MMR Doc. No.

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# Massachusetts Military Reservation

**INSTALLATION RESTORATION PROGRAM**
**322 East Inner Road**
**Otis ANGB, MA 02542**

# Fuel Spill 1 (FS-1)
# Interim Remedial Action Report

## FINAL

## AUGUST 2005

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AFCEE | Air Force Center for Environmental Excellence |
| ANG | Air National Guard |
| AOC | Area of Concern |
| ARARs | applicable or relevant and appropriate requirements |
| AS/SVE | air sparging/soil vapor extraction |
| ASG | Automated Sciences Group |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CLTMP | comprehensive long-term monitoring plan |
| COC | contaminant of concern |
| COPC | contaminant of potential concern |
| CPR | cardiopulmonary resuscitation |
| CQP | Construction Quality Plan |
| CS | Chemical Spill |
| DoD | Department of Defense |
| DQOs | Data Quality Objectives |
| EDB | ethylene dibromide |
| ETD | extraction, treatment, and discharge |
| EW | extraction well |
| FS | Fuel Spill |
| FTA | Firefighter Training Area |
| GAC | granular activated carbon |
| gpm | gallons per minute |
| HAZCOM | hazard communication |
| HAZOP | hazardous operations |
| HAZWOPER | Hazardous Waste Operations and Emergency Response |
| HI | Hazard Index |
| HSP | Health & Safety Plan |
| IRA | interim remedial action |
| IROD | Interim Record of Decision |
| IRP | Installation Restoration Program |
| JE | Jacobs Engineering Group |
| LF | Landfill |
| LTM | long-term monitoring |
| MADEP | Massachusetts Department of Environmental Protection |
| MCL | Maximum Contaminant Level |
| MCLG | Maximum Contaminant Level Goal |

| | |
|---|---|
| µg/L | microgram per liter |
| MMCL | Massachusetts Maximum Contaminant Level |
| MMR | Massachusetts Military Reservation |
| msl | mean sea level |
| NGB | National Guard Bureau |
| NPDES | National Pollution Discharge Elimination System |
| NPL | National Priorities List |
| O&M | operations and maintenance |
| OSHA | Occupational Safety and Health Administration |
| PAH | polynuclear aromatic hydrocarbon |
| PCB | polychlorinated biphenyl |
| PHSM | program health & safety manager |
| PPE | personal protective equipment |
| PRA | Preliminary Risk Assessment |
| PRE | Preliminary Risk Evaluation |
| QA/QC | Quality Assurance/Quality Control |
| QPP | Quality Program Plan |
| RA | remedial action |
| RAH | Risk Assessment Handbook |
| RAO | Remedial Action Objective |
| RI | Remedial Investigation |
| ROD | Record of Decision |
| RPMs | Remedial Project Managers |
| SAP | Sampling and Analysis Plan |
| SI | Site Investigation |
| SD | Storm Drain |
| SPEIM | system performance and ecological impact monitoring |
| SVOC | semivolatile organic compound |
| SWP | shallow well-point |
| TRET | Technical Review and Evaluation Team |
| TCE | trichloroethylene |
| USEPA | United States Environmental Protection Agency |
| USGS | United States Geological Survey |
| VOC | volatile organic compound |
| VPH/EPH | volatile petroleum hydrocarbons/extractable petroleum hydrocarbons |

## 1.0 INTRODUCTION

This Interim Remedial Action Report has been prepared by the Air Force Center for Environmental Excellence (AFCEE) for the Fuel Spill No. 1 (FS-1) plume extraction, treatment, and discharge (ETD) system located in the town of Mashpee, in Barnstable County, Cape Cod, Massachusetts.

Section 1.0 provides general information pertaining to all sites managed by AFCEE at the Massachusetts Military Reservation (MMR) and introduces the operable unit for which the report is written. Section 2.0 provides the regulatory framework and remedial design considerations for the remedial system constructed for the FS-1 source area and associated groundwater plume. Section 3.0 provides a summary description of the activities undertaken to construct and implement the remedial system and Section 4.0 summarizes the major events including significant milestones. Section 5.0 describes the performance standards and quality assurance/quality control (QA/QC) measures related to the construction of the FS-1 remedial system. Information regarding inspections and/or certifications are included in Section 6.0 and operations and maintenance activities are described in Section 7.0. A summary of project costs is included in Section 8.0. Section 9.0 provides observations and lessons learned during the design and construction of the remedial system. Section 10.0 includes contact information for the organizations involved in the cleanup process. Section 11.0 provides references for documentation used in preparing this Interim Remedial action Report. The section entitled **Figures** includes all figures referenced in the main body of the report. **Appendix A** includes the Pre-Final Inspection Project Punch List submitted for construction completion of the FS-1 treatment system. **Appendix B** is Project Note 10, *Summary of FS-1 System Trial Operations and Transfer of Operations to O&M*. **Appendix C** is the official notification of achievement of the Federal Facility Agreement milestone for the startup of the FS-1 treatment system.

### 1.1 General Description

The MMR occupies approximately 22,000 acres within the towns of Bourne, Sandwich, Mashpee, and Falmouth in the upper western portion of Cape Cod, Massachusetts **(Figure 1-1)** on two distinct types of terrain on the Cape Cod Peninsula. The main Cantonment Area lies on a broad, flat, gently southward-sloping glacial outwash plain. Elevation in the area ranges from 100 to 140 feet mean sea level (msl). To the north and west of the Cantonment Area, the terrain becomes hummocky with irregular hills and greater topographic relief, and lies in the southward extent of Wisconsin Age terminal moraines. The elevations north and west of the Cantonment Area generally range from 100 to 250 feet; the highest elevation reportedly is 306 feet. The entire site is dotted with numerous kettle holes and depressions, some of which contain water.

A single groundwater flow system, sole source aquifer, underlies western Cape Cod (from the Cape Cod Canal to Barnstable and Hyannis), including MMR. This aquifer

system is described as unconfined and is recharged by infiltration from precipitation. The highly permeable nature of the sands and gravels underlying the area allow for rapid infiltration of rainfall, which greatly reduces surface water runoff. The high point of the water table, or the top of the groundwater mound within the western Cape Cod groundwater system, is located beneath the northern portion of MMR. Flow is generally radially outward from this mound. The ocean forms the lateral boundary of the aquifer on three sides, with groundwater discharging into Vineyard Sound and Nantucket Sound on the south, Buzzards Bay on the west, and Cape Cod Bay on the north. The Bass River in Yarmouth forms the eastern lateral boundary.

Portions of MMR have been used for military training purposes since 1911, with most activity occurring after 1935. The level of activity at MMR has varied over its operational history. MMR has been used for army training and maneuvers, military aircraft operations, maintenance, and support. Five military units currently operate at MMR: Massachusetts Army National Guard (Camp Edwards), Massachusetts Air National Guard (Otis Air National Guard Base), U.S. Air Force, U.S. Coast Guard, and the Veterans Administration.

## 1.2 Operations and Waste Management Practices

Beginning in the 1930s, aircraft runways, aircraft and vehicle maintenance areas, landfills, and firefighter training areas were used for military activities. Between 1955 and 1972, Air Force operations included the use of petroleum products and other hazardous materials such as fuels, motor oils, and cleaning solvents and the generation of associated wastes. Consistent with practices of other industries at the time, it was common practice for many years at MMR to dispose of such wastes in landfills, drywells, sumps, and the sewage treatment plant. Spills and leaks also occurred. These activities have resulted in serious impacts to the Upper Cape's groundwater resources. Today the generation, use, and disposal of hazardous materials is strictly managed and regulated to protect the environment.

The suspected source area of the FS-1 groundwater plume is located in the southeastern portion of MMR adjacent to Taxiway E. Previous records searches identified historical base activities associated with fuel management practices that occurred at Area of Concern (AOC) FS-1. The 551$^{st}$ Airborne Early Warning and Control Wing, stationed at MMR from 1955 to 1970, was responsible for maintaining EC-121 Super Constellation aircraft. These activities included testing fuel dump valves, which reportedly occurred in the vicinity of the Eastern Aircraft Turnaround and the Western Aircraft Turnaround located west of Taxiway E. Records searches indicate that EC-121 Super Constellation aircraft were parked there and fuel valves were tested. The valves were opened and the fuel allowed to drain. Initially, records suggest the fuel was hosed off the concrete. Records also indicate that the fuel was collected in 55-gallon barrels. The exact quantity of fuels released onto the concrete is unknown.

## 1.3 Regulatory and Enforcement History

In 1982, the Department of Defense (DoD) initiated a multi-phase Installation Restoration Program (IRP) to identify and evaluate problems associated with past hazardous waste disposal and spills at DoD installations, including National Guard Bureau (NGB) facilities. An IRP office was established at MMR in 1990. The IRP performs environmental restoration activities that follow the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidelines, and is conducted in seven stages, as follows:

- identification of potential hazardous waste sites
- confirmation of the presence of hazardous materials at the site
- determining the type and extent of contamination during the Remedial Investigation
- evaluation of alternatives for cleanup of the site in a Feasibility Study
- proposal of a cleanup remedy in a Proposed Plan
- selection of a remedy
- preparation of a Record of Decision (ROD)
- implementation of the remedy for cleanup of the site

Both private sector and federal facility sites are eligible for placement on the United States Environmental Protection Agency (USEPA) National Priorities List (NPL). In July 1989, the USEPA proposed MMR for inclusion on the Federal Superfund NPL. USEPA formally added MMR to the NPL on November 21, 1989. Therefore, MMR is subject to the special provisions for federal facilities under the CERCLA Act of 1980.

Federal military sites such as MMR receive funding from the DoD Environmental Restoration Account and not from the Hazardous Substances Superfund under CERCLA. On July 17, 1991, the Air National Guard (ANG) and USEPA Region 1 entered into a Federal Facility Agreement that outlines cleanup policies and procedures at MMR. Also in 1991, a Defense State Memorandum of Agreement, a cooperative agreement between the DoD and the Commonwealth of Massachusetts, was issued to provide funding for state regulatory oversight.

## 1.4 Site Investigation Activities

Between 1982 and 1985, the IRP identified 73 areas of concern and recommended 21 sites be investigated first. Site investigations completed at the 21 areas of concern discovered contaminants including volatile organic compounds (VOCs), polychlorinated

biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), semivolatile organic compounds (SVOCs), metals, and fuel-related compounds.

Investigations completed to date have identified 16 groundwater plumes originating from MMR. These include Ashumet Valley, Chemical Spill 4 (CS-4), CS-10, CS-19, CS-20, CS-21, CS-23, Eastern Briarwood, FS-1, FS-12, FS-13, FS-28, FS-29, Landfill 1 (LF-1), Storm Drain 5 (SD-5), and Western Aquafarm. Two of the plumes, (i.e., Eastern Briarwood and Western Aquafarm) no longer exist and have been reclassified by the Remedial Project Managers (RPMs) due to lack of contaminant concentrations in the aquifer above any regulatory standard.

Additional information regarding investigations at the areas of concern/sites and their remediation status can be found in the IRP Community Involvement Plan dated July 2000. This plan is also available on the MMR website at www.mmr.org.

## 1.5 Removal and Remedial Activities

In 1992, the first MMR Interim Record of Decision (IROD) was signed for the CS-4 groundwater plume treatment system, which began operation in 1993. Also in 1992, a proposed plan was presented to the public illustrating the proposed remedy to construct a multilayer capping system for 60 acres of the main base landfill (LF-1), the source of the LF-1 groundwater plume. The following year, an IROD was signed for three sections of the main base landfill (LF-1) and construction of the landfill caps was initiated.

In 1994 the IRP began to treat contaminated soil at several source areas, including CS-4. In 1995 an air sparging/soil vapor extraction (AS/SVE) system was constructed and began operation to remove fuel from the FS-12 source area. Also in 1995, excavation and thermal treatment of the contaminated soil at the former firefighter training area 1 (FTA-1) began and the landfill cap was completed. In addition, an IROD was signed for seven groundwater plumes: Ashumet Valley, CS-10, Eastern Briarwood, FS-12, LF-1, SD-5, and Western Aquafarm. It was decided that all but two of the plumes would be remediated. Eastern Briarwood and Western Aquafarm would undergo long-term monitoring (LTM). In 1996, an evaluation of the 60% design for simultaneous containment of the groundwater plumes determined that it could not be accomplished without adversely affecting the ecosystem on the Upper Cape and the design was deemed environmentally unacceptable.

To address the 60% design issues, a specialized group referred to as the Technical Review and Evaluation Team (TRET) was established. The TRET included environmental experts from the USEPA, Massachusetts Department of Environmental Protection (MADEP), and the United States Geological Survey (USGS). In 1996 the TRET issued a report entitled "Toward a Balanced Strategy to Address Contaminated Groundwater Plumes at the Massachusetts Military Reservation," which contained newly developed design criteria and containment strategies and made recommendations to

proceed with groundwater plume remediation efforts while avoiding adverse ecological impacts. The NGB brought in AFCEE, which contracted Jacobs Engineering Group (JEG) for the design and construction of the groundwater treatment systems. AFCEE and JEG utilized the 60% design and the TRET report to design and build the FS-12 and SD-5 North treatment systems. An additional process, referred to as the Decision Criteria Matrix, was implemented for subsequent remediation systems (i.e. LF-1, Ashumet Valley Axial, CS-10, and SD-5 South) to allow for additional community input.

Also in 1996, 106 underground drainage structures containing contaminated liquid and sediments were removed. Over 30,000 linear feet of drilling for monitoring, extraction, and reinjection wells were completed for construction of the FS-12 and SD-5 North groundwater treatment systems and various investigations. A pilot project began in two areas of the CS-10 plume, testing the effectiveness of two types of recirculating well technology, and a carbon filtration unit for a municipal water supply well in the Town of Falmouth started operation.

Intensive construction and operation activities for groundwater treatment began in 1999. Treatment systems were constructed and began operation at Ashumet Valley, LF-1, CS-10 Sandwich Road, and CS-10 In-Plume. Recirculating well treatment systems were installed underground and began operation to address a portion of the SD-5 South plume. In 2000, extraction wells were installed to remove contaminants from the CS-10 trichloroethylene (TCE) plume and portions of the SD-5 South plume. The extracted water was treated by the existing system built for SD-5 North (also called the Sandwich Road Treatment Facility). The CS-10 South/Southwest treatment system, a modification to the existing CS-10 In-Plume treatment system, began operation in April 2000.

Also in 2000, two RODs were signed: one for four groundwater plumes (CS-4, CS-20, CS-21, and FS-13) and another for the FS-1 source area and groundwater plume. A proposed plan was released in February for the FS-28 and FS-29 groundwater plumes, and the final ROD was signed in October 2000. **Figure 1-2** presents a plume map of MMR.

## 1.6 FS-1 Groundwater Treatment System

The FS-1 plume is located along the southeast portion of MMR, extends into the Town of Mashpee, and ultimately discharges into the Quashnet River. The Quashnet River is fed by a controlled head gate located on the northeast corner of Johns Pond. From there, the river flows through the large cranberry bog adjacent to Johns Pond and onward to Waquoit Bay. The upper reaches of the Quashnet River are fed by groundwater discharge. The plume is approximately 6,525 feet long, a maximum of 1,200 feet wide, and up to 180 feet thick. The FS-1 source area was used by the 551$^{st}$ Airborne Early Warning and Control Wing between 1950 and 1970 to test aircraft fuel dump valves. The aircraft's valves were opened and aircraft fuel was allowed to drain onto the concrete surface. The exact quantity of fuel released is unknown. The contaminant of concern

(COC) in the FS-1 plume is ethylene dibromide (EDB). EDB is an aviation fuel additive that migrated southward in groundwater toward the Quashnet River and was initially detected in the surface water of the Quashnet River and bogs in August 1997.

In April 1999, to reduce and contain contamination at the leading edge of the FS-1 plume on an expedited basis, AFCEE accelerated a portion of the FS-1 contaminated groundwater cleanup under a pilot test system known as the Quashnet River and Bogs System Pilot Test. The intent of this pilot test was to prevent upwelling of EDB-contaminated groundwater into the Quashnet River and associated cranberry bogs. The pilot test involved active treatment of deep and shallow groundwater via a single deep extraction well and a series of 175 shallow well-points. The total flow rate of the treatment system ranged from approximately 650 gallons per minute (gpm) at system startup to 750 gpm after a series of treatment system optimizations. The contaminated groundwater was pumped to a treatment building and treated by two granular activated carbon (GAC) vessels. The treated water was discharged under a USEPA discharge permit to the water table via a shallow infiltration trench (120 gpm) and to the surface water via a discharge "bubbler" (remaining flow). Additionally, earthen berms were constructed to physically separate the area being remediated from the active bogs so that contaminated surface water would not flow into the developed bogs in the event of a treatment system shutdown (i.e. due to fire, power outage, etc…).

The pilot test ended in October 2002, when a fire destroyed the treatment plant. Surface water sampling conducted in the Quashnet River after the fire detected low levels of EDB; however, the concentrations did not pose a risk to human health or the environment. Approximately 1.2 billion gallons of contaminated groundwater was treated during the lifecycle of the pilot test, achieving approximately 47% of its total mass cleanup goal.

The new FS-1 remedial system, which is the subject of this report, became operational on October 1, 2003 and is presented in detail in section 2.3.2 of this report.

## 2.0 FS-1 BACKGROUND

AOC FS-1 was identified in IRP records searches and Phase II studies as a potential source of environmental impact resulting from historical fuel management practices. The presence of groundwater contamination extending downgradient from the source area was confirmed during Site Investigation (SI) activities conducted in 1987 and 1988. Based on results of the SI, Remedial Investigation (RI) activities were conducted in 1989 to further define the extent of contamination at the source area and in downgradient groundwater.

The purpose and scope of the 1991 RI was to (1) conduct additional source investigations to provide data to assess potential soil and groundwater contamination; and (2) evaluate the horizontal and vertical distribution of groundwater contamination migrating from the source area. E.C. Jordan conducted the FS-1 Study Area RI as part of the Task 2-5 field program, which evaluated suspected contamination at six MMR study areas designated by the MADEP as priority areas. The RI summarized the results of the RI field program completed during the summer and fall of 1989 at the FS-1 Study Area, augmented with results from previous site investigations.

A Supplemental RI report for AOC FS-1 was completed in 1999. The purpose and scope of the Supplemental RI report was to incorporate available data from previous investigations at AOC FS-1 into a summary document that evaluates human health and ecological risks in accordance with guidelines established in the MMR Risk Assessment Handbook (RAH) (ASG, 1994). A comprehensive interpretation of all available data was intended to fill data gaps identified during review of the Draft RI report and complete the RI process at the site. Additional surface soil samples were collected at the source area in September 1995 to provide additional data for the risk assessment. A Supplemental RI sampling event was performed in 1997 and 1998. Those events were based on a groundwater model that suggested that previous investigations did not evaluate all possible flow paths. Additional groundwater, surface water, and sediment samples were collected in the Quashnet River area to further characterize impacts to the Quashnet River and bogs (AFCEE, 1999).

The Supplemental RI report also included pertinent data from studies not directly related to AOC FS-1. Data from various wells installed downgradient from the FS-1 source area during the Mashpee Groundwater Study, Task 5, the Southeast Region Groundwater Operable Unit RI, and data collected by AFCEE were incorporated into the supplemental RI (AFCEE, 1999).

COCs were selected based on compound concentration and resulting human and ecological exposures, and compound toxicity. Criteria used for the selection of COCs for human health and ecological risk characterization are discussed in the following paragraphs.

Baseline Risk Assessment

The baseline risk assessment was presented in the Supplemental RI in two parts. The first part quantified the baseline risk to human health and the second quantified the potential impact to ecological receptors. Baseline risks are the potential risks to human health and ecological receptors assuming that no remedial actions are implemented (AFCEE, 1999).

Human Health Risk Assessment

The baseline risks to human health from the AOC FS-1 study area soil, groundwater, surface water, and sediment were evaluated. Current and future land use and potential receptors were described. Finally, cancer and non-cancer risks were calculated and compared to risk guidelines to determine which chemicals of potential concern, if any, present an unacceptable risk to human health.

The purpose of the baseline human health risk assessment was to estimate the potential threat to human health for both current and future use scenarios, assuming no actions were taken to mitigate risks. This process included sufficiently characterizing the contaminants, potential exposures, and potential populations to determine what risks need to be reduced or eliminated, what exposures need to be prevented, and what actions were necessary to reduce risk. The baseline human health risk assessment was conducted in accordance with USEPA methods for estimating risks at Superfund sites using existing guidance. The human health risk assessment was presented in the suggested USEPA format and included data evaluation, toxicity assessment, exposure assessment, risk characterization, and evaluation of uncertainty (AFCEE, 1999).

Ecological Risk Assessment

The ecological risk assessment was a qualitative evaluation of the potential impacts of contaminants of potential concern (COPCs) on wildlife species. This assessment included a screening level risk assessment that identified potentially impacted habitats, COPCs, exposure pathways, target receptors, and appropriate assessment/measurement endpoints.

This ecological risk assessment was conducted according to Ecological Risk Assessment Guidance for Superfund with some modifications to take advantage of the site-specific information already developed at MMR. In accordance with USEPA guidance, the assessment began with a screening-level problem formulation and ecological effects evaluation. The USEPA screening-level risk assessment was equivalent to the preliminary risk evaluation (PRE) and preliminary risk assessment (PRA) process described in the MMR RAH. It was also equivalent to the Stage I Environmental Screening in Guidance for Disposal Site Risk Characterization under the Massachusetts

Contingency Plan and the Tier I Analysis under the Tri-Service Procedural Guidelines for Ecological Risk Assessments (AFCEE, 1999).

The screening-level risk assessment identified chemicals that may pose risk to terrestrial receptors identified at the AOC and aquatic receptors and semi-aquatic receptors identified at the groundwater plume and upwelling area. Exposure pathways were identified for each receptor, and the potential risks were quantified. Conservative screening ecological toxicity values, conservative assumptions regarding toxicity factors, and exposure parameters for receptors were used in the screening level risk assessment, which is designed to avoid underestimating risk. The assessment proceeded to the baseline risk assessment for those receptors with COPCs exceeding the screening level assessment endpoints.

Terrestrial plants were identified as an ecological receptor group at the AOC and evaluated for phytotoxicity. Five species considered representative of those animals that may occur at AOC FS-1 currently (or in the future) were selected according to the RAH (Sect. 3.3.2.1 and RAH Appendix Q) (ASG, 1994). The five species were selected for evaluation because they represented various trophic levels including omnivorous mammals, herbivorous mammals, insectivorous mammal, omnivorous bird, and carnivorous bird. The selected species were the red fox, white-footed mouse, short-tailed shrew, cardinal, and grasshopper sparrow (AFCEE, 1999).

Risk Assessment Conclusion

No hazards or risks greater than the state or federal regulatory limits were found for human health exposure to surface soil located in the FS-1 source area. No COCs were identified for soil. The primary risk to human receptors is from the potential consumption of groundwater from the plume. The cancer risks for future residential exposure using mean and maximum groundwater concentrations are $6x10^{-4}$ and $2x10^{-2}$, respectively. The hazard indices (HIs) for the future residential use of groundwater from the plume are 3.2 and 20 for the mean and maximum groundwater concentrations, respectively. The primary contaminant contributing to risk was EDB for carcinogens and non-carcinogens. For cancer risks, EDB and arsenic had individual pathway risks greater than $1x10^{-5}$ for the mean concentrations. The maximum concentrations had cancer risks greater than or equal to $1x10^{-5}$ for EDB, chloroform, and arsenic. The HI for the individual groundwater pathways showed HIs greater than 1.0 for EDB only with mean concentrations and for EDB, toluene, chloroform, arsenic, and iron. Maximum lead levels in groundwater exceed the USEPA standard at the source area. Thallium was also identified as exceeding the maximum contaminant level (MCL) at one well location in the plume. The total cancer risk for the adult wader who consumed fish using the maximum concentrations was $6x10^{-5}$ and all risk was from exposure to EDB. It was determined to be unlikely that a single individual would ingest fish of edible size solely from the Quashnet River and in the quantity used in this risk estimate. Adverse effects to

ecological receptors, birds, mammals, amphibians, fish, or benthic invertebrates are also not likely from the soil, surface water, or sediment at AOC FS-1 (AFCEE, 1999).

RI Recommendations

Based on the scope of previous investigations at AOC FS-1, sufficient characterization of surface soil, subsurface soil, groundwater, downgradient surface water, and sediments has been performed to accurately evaluate conditions necessary to evaluate associated human health and ecological risks. Carcinogenic human health risks and non-carcinogenic hazards were determined to be greater than regulatory target levels for groundwater and downgradient surface water. Because of these risks, the RI recommended further action at FS-1 with regard to groundwater and downgradient surface water. Risk evaluation of soils in the source area did not indicate levels of contamination in surface soil or subsurface soil warranting further action. Therefore, no further action was recommended for source area soils. It was recommended that a Feasibility Study be conducted to identify appropriate actions for groundwater and downgradient surface water (AFCEE, 1999).

## 2.1 Record of Decision Requirements for AOC FS-1

The *Record of Decision Area of Contamination FS-1* presents the selected remedial actions for AOC FS-1 at MMR. The AOC includes both source area and groundwater associated with FS-1. The selected remedial alternative was Alternative 3B (Axial and Leading Edge Extraction, Treatment, and Reinjection/Discharge). The Proposed Plan presenting the remedy was issued in June 1999 for public comment, and no comments were received (AFCEE, 2000a).

The selected response for AOC FS-1 was composed of multiple components. In the source area, no action was required for surface soils since, as concluded by the FS-1 RI, there were no risks warranting action. For the downgradient groundwater contamination, the selected remedy (Alternative 3B) was leading edge and axial extraction, treatment, and reinjection/discharge. Monitoring was selected for the source area groundwater.

In summary, the remedy provides for:

- extracting contaminated groundwater from the contaminant plume and potentially extracting groundwater from hot-spot areas identified during remedial design;
- pumping and conveying the extracted groundwater to a treatment system to remove contaminants;
- discharging the treated water back to the groundwater and/or surface water;
- installing monitoring wells, measuring water levels, and sampling groundwater to monitor the performance of the extraction system;

- sampling the influent and effluent of the treatment system to monitor its performance;
- monitoring of source area groundwater for thallium, toluene, and lead;
- restricting groundwater use within the areas contained by the treatment system through imposition of institutional controls; and
- conducting a review after five years of operation to ensure the remedy provides adequate protection of human health and environment.

The response addresses the principal threat by removing EDB-contaminated groundwater and surface water by extraction, treatment, and reinjection/discharge. Over the course of remediation, surface water contamination would be eliminated because the groundwater source causing surface water contamination would be remediated. The response addresses the low-level threats (toluene, lead, and thallium) contained in source area groundwater by monitoring source area groundwater to ensure that those contaminants do not migrate away from the source area. A groundwater monitoring and site visual inspection program would be implemented. The intention of the extraction, treatment, and reinjection/discharge system was to reduce the toxicity, mobility, and volume of contaminated groundwater by extracting groundwater and treating that water to remove EDB.

Cleanup Goals

Remedial Action Objectives (RAOs) are the site-specific qualitative goals. Specifically, the objectives include:

- Prevent or reduce exposure to groundwater COCs exceeding cleanup standards in groundwater;
- Restore the aquifer to beneficial uses within a reasonable timeframe; and
- Prevent or reduce worker, recreational youth, and adult wader contact with Quashnet River water containing unacceptable concentrations of EDB and ingestion of fish exposed to Quashnet River water containing unacceptable concentrations of EDB.

Cleanup standards to achieve RAOs include federal MCLs, non-zero federal MCL Goals (MCLGs), Massachusetts MCLs (MMCLs), or risk-based guidance levels for compounds for which drinking water standards have not been set. **Table 2-1** presents COCs and their respective cleanup levels.

| Table 2-1 Contaminants of Concern and Respective Cleanup Levels for FS-1 Plume | | | |
|---|---|---|---|
| **Contaminant** | **Basis** | **Concentration (µg/l)** | **Standard** |
| EDB | Human Health | 0.02 | MMCL |
| Lead | Human Health | 15 | Federal Action Level |
| Thallium | Human Health | 2 | Federal Action Level |
| Toluene | Human Health | 1,000 | Federal Action Level |

Institutional Controls

Institutional controls were employed that included placing zoning restrictions on the AOC to limit site activities. Identified restrictions include restrictions preventing use of impacted groundwater.

Institutional controls for FS-1 involve on-base and off-base authorities. For source area groundwater, there is no immediate risk. Residents and workers on the base obtain drinking water from the base water supply system. Construction projects on MMR, including water supply wells, require written approval from the Base Civil Engineer. Construction of a new drinking water supply well for MMR would require MADEP permission.

For downgradient groundwater, institutional controls have been enacted by the Town of Mashpee. On April 23, 1998, the Mashpee Board of Health adopted a moratorium on groundwater wells in the Town of Mashpee in an effort to implement institutional controls to better protect the public health and welfare of its citizens. This regulation reads: existing and future residential wells located in documented or anticipated areas of groundwater contamination as defined by the Board of Health are herewith restricted from use for any purpose, including drinking, any agricultural use (lawn watering, gardening, livestock watering, irrigation of crop land, etc.), washing vehicles, pool filling, etc. This moratorium includes groundwater wells owned by residents currently connected to a public water supply.

Monitoring Requirements

The FS-1 System Performance and Ecological Impact Monitoring (SPEIM) program consists of evaluating the performance of the remedial system and its effects on the surrounding ecosystems. The original treatment system monitoring program was presented in the *Quashnet River and Bogs Pilot Test Monitoring Plan* and subsequent project notes with modifications in annual SPEIM reports. The plans consisted of three main components: treatment plant monitoring, remedial system impact monitoring, and risk monitoring. The monitoring consisted of treatment plant influent and effluent sampling, groundwater and surface water sampling, hydraulic monitoring (including groundwater elevations and stream gauging), and evaluation of fish populations (AFCEE 2004b).

In accordance with the selected remedy, monitoring site conditions involves collecting and analyzing groundwater and surface water samples. Additionally, wells in the source area were resampled for metals and VOCs to verify the presence of VOCs and metals above background and MCLs.

Operation and Maintenance Requirements

The ROD specified that the contaminated groundwater would be extracted from the aquifer, pumped to a treatment system, treated to remove the contaminants, then returned to the aquifer or used in another beneficial manner. The ROD also specified that the influent and effluent of the treatment system would be monitored to ensure the system is performing as designed.

The ROD also calls for a review every five years of ETD system operation to ensure the remedy provides adequate protection of human health and the environment. These reviews are intended to:

- provide a history of the operations of the treatment system over the previous five years;
- present the sampling results from the treatment system, performance monitoring activities, and ecological monitoring activities;
- present an evaluation of the five years of operation, including an assessment of whether the system has performed according to expectations and objectives; and
- recommend the need, if any, for modifications to the system or operating parameters.

The treatment system will be shut down upon approval by the regulators, which is expected to be granted when the plume has been cleaned up to MCLs, or background levels (if technically and economically feasible), or when the required five-year reviews present sufficient data to demonstrate that further operation of the systems is unfeasible to achieve further reductions in contaminant levels.

Design and Construction Requirements

The selected alternative was Alternative 3B, Axial and Leading Edge Extraction, Treatment, and Reinjection/Discharge. Alternative 3B included:

- Additional modeling to optimize the extraction system.
- Sampling and analysis to verify the boundaries of contamination that exceeds the MCLs.
- Installation of additional bounding wells.
- Site preparation by constructing road(s) along the proposed path of extraction wells.
- Installation of power and well controls wiring along the roadway(s).
- Installation of 17 deep axial extraction wells pumping at approximately 400 gpm.
- Installation of one deep extraction well pumping at approximately 200 gpm.
- Installation of 135 shallow well-points pumping at a total of 400 gpm.
- Installation of 19 reinjection wells capable of injecting 200 gpm.
- Construction of a surface water discharge system capable of discharging 800 gpm to the bog area.
- Construction of berms to separate areas of upwelling contaminated groundwater from areas in the bog where contaminated groundwater does not upwell.
- Construction of an additional treatment facility capacity using activated carbon adsorption to create a treatment facility capable of treating 1,000 gpm.
- Operation and maintenance of the system for seven years.
- Performance of an ecological sampling program to ensure that groundwater extraction, treatment and reinjection/discharge does not impact sensitive aquatic habitat.
- An agreement that AFCEE would conduct a round of fish sampling in 2000 and 2001 as a measure of meeting the remedial action objective related to surface water. Identified objectives included evaluation of the fish ingestion pathway and determination of environmental impact on the fish in the surface water of the Quashnet River cranberry bog complex.
- Completion of construction activities associated with the Quashnet River Bogs Pilot Test.

Implementation of the axial well extraction system and enlargement of the treatment facility and discharge system were required to begin within 15 months of signature of the final ROD (see **Figure 2-1**).

## 2.2 Basis for Determining Cleanup Goals for the FS-1 Groundwater Plume

The objectives of the plume remediation system were defined in the ROD and were used as the basis for determining cleanup goals. The objectives are described as follows:

- Prevent or reduce exposure to groundwater contaminants of concern exceeding cleanup standards in groundwater,
- Restore the aquifer to beneficial uses within a reasonable timeframe, and
- Prevent or reduce worker, recreational youth, and adult wader contact with Quashnet River water containing unacceptable concentrations of EDB and ingestion of fish exposed to Quashnet river water containing unacceptable concentrations of EDB.

In addition to the remedial action objectives identified in the ROD, there were other considerations evaluated during the development and evaluation of final wellfield design scenarios. These considerations included the ecological setting of the area, cultural resources, property access, applicable or relevant and appropriate requirements (ARARs), stakeholder input, and cost. An assessment of the potential impacts of the design on cultural resources that may be present in the area was completed in accordance with Section 106 of the National Historic Preservation act.

## 2.3 Remedial Design

### 2.3.1 FS-1 Source Area

A remedial design was not needed for the FS-1 source area because the source area soils did not present a direct contact human health or ecological threat. A long-term groundwater monitoring program was developed to monitor source area groundwater and on-base restrictions exist to prevent the groundwater underneath the source area from being used as a drinking water supply.

### 2.3.2 Quashnet River and Bogs Pilot Test System FS-1 Groundwater Plume

Prior to implementation of the FS-1 ROD, an interim treatment system known as the Quashnet River and Bogs System Pilot Test was implemented to accelerate capture of the leading edge of the FS-1 plume. The pilot test system began operation in April 1999 and ceased operation in October 2002 due to a fire that destroyed the treatment plant. The pilot test system was designed to reduce and, if possible, prevent EDB associated with the FS-1 plume from reaching the surface water of the Quashnet River and bogs without impacting the existing ecosystem. The pilot test system consisted of a deep extraction well and 175 shallow groundwater extraction wells with a total flow rate of 650 gallons per minute, a treatment plant utilizing granulated activated carbon, a reinjection trench, a

surface water discharge bubbler, and the construction of berms to separate the potentially contaminated Quashnet River from adjacent cranberry bogs. The deep extraction well was designed to intercept and hydraulically contain the plume and reduce the time that the shallow extraction wells would need to be in operation. The shallow wells were designed to intercept the shallow groundwater (0 to 20 feet) entering the adjacent bogs and surface water. Treated groundwater was discharged under a USEPA discharge permit (NPDES Exclusion Permit Number 99-094) to the surface water of the K2 bog west ditch via a bubbler, and to a shallow groundwater infiltration trench located along the northern side of the K1 bogs. **Figure 2-2** shows the pilot test system layout.

### 2.3.3 Final Wellfield Design FS-1 Groundwater Plume

The final FS-1 wellfield design was based on the results of pre-design investigation activities, subsequent groundwater model revisions, and analysis of a range of wellfield design scenarios that met or exceeded the ROD goals. The FS-1 remedial system began operation in October 2003, and is expected to operate for at least 15 years (AFCEE, 2001).

The principal features of the new FS-1 remedial system include: (1) a new treatment plant with three 20,000-lb GAC vessels operated in series to remove EDB from the groundwater while reducing the frequency of carbon changes; (2) the existing extraction well (36EW0005) from the pilot test, together with a new extraction well (36EW0001) used to remediate the southern portion of the plume and replace the shallow well-point extraction system; (3) the addition of two extraction wells (36EW0007 and 36EW0011) to remediate the central portion of the plume; and (4) the three existing bubblers to discharge the treatment plant effluent to the K1 and K2 bog ditches (under the existing discharge permit).

The former shallow groundwater infiltration trench, installed for the pilot test system, is no longer utilized. During the pilot test operation, the infiltration ditch experienced flooding (discharging water to the surface), and it was found that bypassing the infiltration ditch and discharging the flow through bubblers resulted in improved stream conditions more favorable for fishery habitat, including trout spawning. Therefore, AFCEE, in consultation with the USEPA, MADEP, the Massachusetts Division of Fisheries and Wildlife and the Town of Mashpee, discontinued use of the infiltration ditch.

The FS-1 shallow well-point (SWP) groundwater extraction system was decommissioned in November 2003. The SWP system consisted of 175 SWPs, and a skid pump with piping and valves located in a pump house. Of the original 175 SWPs, 161 were decommissioned and the remaining retained for groundwater monitoring. The skid pump and piping were removed from the pump house, and the building was turned over to the Town of Mashpee in January 2004.

**Figure 2-3** presents the FS-1 remedial system as presented in the wellfield design. The preparation of the final wellfield design also benefited from regulatory agency and stakeholder input.

## 2.4 Final ROD Amendments

In December 2001 AFCEE issued Fact Sheet #2001-11 entitled FS-1 Post-ROD Change. The purpose of this fact sheet was to document the elimination of the ROD requirement to perform fish sampling and analysis in the Quashnet River. This decision was made by AFCEE and the regulatory agencies after a comprehensive review of fish sampling and surface water data. This action was considered a minor change to the ROD because it does not change the overall approach to cleaning up the FS-1 groundwater contamination.

The original wellfield design (Figure 2-2) was modified to optimize plume capture, based on computer simulations of the groundwater plume. The changes, made in coordination with the USEPA and MADEP, did not constitute a significant change to the selected remedy, and a ROD Amendment or Explanation of Significant Differences was not required.

## 3.0 CONSTRUCTION ACTIVITIES

### 3.1 FS-1 Source Area

No Action.

### 3.2 FS-1 Groundwater Plume

This section provides information on construction and monitoring activities associated with the FS-1 groundwater remediation system.

Construction

Preconstruction activities consisted of acquiring applicable construction permits and property access. Utilities were contacted and coordinated. Staging areas were established and traffic flow patterns were developed while considering easement restrictions and minimizing traffic through residential areas. Pre-mobilization meetings and underground utility clearances were conducted. Additional data were collected through installation of new monitoring wells and analyzed to determine if additional pump tests were needed prior to construction.

**Table 3-1** provides a detailed chronological summary of the activities involved in the construction of the FS-1 groundwater remediation system.

**TABLE 3-1**
**FS-1 EXTRACTION/TREATMENT/DISCHARGE SYSTEM**

| DATE | EVENT |
|---|---|
| January 17, 2003 | Started clearing and installation of the new extraction wells. Wells were installed first with a sonic drill rig and then completed with a barber drill rig. |
| March 25, 2003 | The two original GAC vessels were removed from the original FS-1 pilot system location. |
| May 14, 2003 | Clean Harbors began excavation activities for the pipeline connecting the new extraction wells and the treatment plant. |
| May 19, 2003 | Began setting the well vaults. |
| May 21, 2003 | Horton Construction, the general contractor for plant construction started work activities. |
| June 6, 2003 | Horton Construction began excavation activities for the building foundation's slab extension. |
| June 11, 2003 | Horton Construction began pouring concrete for the new treatment plant's foundation. |
| June 19, 2003 | Three new GAC vessels were installed. |
| June 24, 2003 | Clean Harbors installed piping for the GAC vessels. |
| July 15, 2003 | Boston Electric started electrical work at the treatment plant. |

| TABLE 3-1 (continued)<br>FS-1 EXTRACTION/TREATMENT/DISCHARGE SYSTEM | |
|---|---|
| **DATE** | **EVENT** |
| July 24, 2003 | Horton Construction began erecting the structural steel. |
| August 5, 2003 | Clean Harbors began installation of the remaining treatment plant piping. |
| August 12, 2003 | Horton Construction completed concrete placements in the plant. |
| August 13, 2003 | Boston Electric completed electrical line to the vaults, and started work in the vaults. |
| September 3, 2003 | Boston Electric started pulling fiber optic cable to the well vaults. |
| September 4, 2003 | Clean Harbors began developing the extraction wells. |
| September 9, 2003 | NStar installed permanent plant power from the main transformer. |
| September19, 2003 | Clean harbors performed hydro-testing of all piping within the building. |
| September 20, 2003 | Clean Harbors performed hydro-testing of frac tank piping. |
| September 22, 2003 | Envirotrol delivered first load of carbon for the GAC vessels. |
| September 24, 2003 | Additional carbon loaded in GAC vessels |
| September 29, 2003 | Horton Construction essentially completed construction of the building and installation of the siding. |
| October 1, 2003 | JEG began startup procedures. |
| October 16, 2003 | The treatment plant was operated overnight with all wells at design flow. O&M is now operating the treatment plant. |
| October 16, 2003 through November 14, 2003 | The 30-day run-in period is initiated. Some starts and stops occurred during the 30 days, but in general, the plant operated continuously from October 16 through November 14, 2003. |
| November 2003 | Shallow well-point groundwater extraction system decommissioned |

Monitoring

The FS-1 SPEIM program consists of evaluating the performance of the remedial system and its effects on the surrounding ecosystems. The original treatment system monitoring program was presented in the *Final Quashnet River and Bogs Pilot Test Monitoring Plan* and subsequent project notes with modifications in annual SPEIM reports (AFCEE 2004b). The plans consisted of treatment plant monitoring and remedial system impact monitoring. The monitoring consisted of treatment plant influent and effluent sampling, groundwater and surface water sampling, and hydraulic monitoring (including groundwater elevations and stream gauging).

The groundwater sampling locations, monitoring rationale, parameters measured, and sampling frequency for the FS-1 chemical and hydraulic networks are presented in **Table 3-2** and **Table 3-3**, respectively. The FS-1 chemical, hydraulic, and surface water monitoring networks are depicted in **Figure 3-1**, **Figure 3-2**, and **Figure 3-3**,

respectively. Well construction information for the FS-1 SPEIM network is presented in **Table 3-4**.

**Table 3-2**
**FS-1 Chemical Monitoring Network**
**Comprehensive Long-Term Monitoring Plan**

| Location | Rationale For Monitoring | Frequency | Parameters |
|---|---|---|---|
| 00MW0552A | South of the FS-1 leading edge, outside plume boundary. | SA | EDB |
| 00MW0552B | South of the FS-1 leading edge, outside plume boundary. | SA | EDB |
| 36EW0001 | Extraction well in the southern portion of the FS-1 plume. | M | EDB |
| 36EW0005 | Extraction well in the southwestern portion of the FS-1 plume. | M | EDB |
| 36EW0007 | Extraction well in the southeastern portion of the FS-1 plume. | M | EDB |
| 36EW0011 | Extraction well in the central portion of the FS-1 plume. | M | EDB |
| 36EW4010 | Monitor shallow groundwater adjacent to the K2 bog east ditch. | SA | EDB |
| 36EW4020 | Monitor shallow groundwater adjacent to the K2 bog east ditch. | SA | EDB |
| 36EW4035 | Monitor shallow groundwater adjacent to the K2 bog east ditch. | SA | EDB |
| 36EW4044 | Monitor shallow groundwater adjacent to the K2 bog east ditch. | SA | EDB |
| 36EW4046 | Monitor shallow groundwater adjacent to the K2 bog east ditch. | SA | EDB |
| 36EW4054 | Monitor shallow groundwater adjacent to the K2 bog east ditch. | SA | EDB |
| 36EW4065 | Monitor shallow groundwater adjacent to the K2 bog east ditch. | SA | EDB |
| 36EW4074 | Monitor shallow groundwater adjacent to the K2 bog east ditch. | SA | EDB |
| 36EW4084 | Monitor shallow groundwater adjacent to the K2 bog east ditch. | SA | EDB |
| 36EW4090 | Monitor shallow groundwater between the K2 and K6 bogs. | SA | EDB |
| 36EW4100 | Monitor shallow groundwater between the K2 and K6 bogs. | SA | EDB |
| 36EW4132 | Monitor shallow groundwater immediately north of the K6 bog. | SA | EDB |
| 36EW4135 | Monitor shallow groundwater immediately north of the K6 bog. | SA | EDB |

| Table 3-2 (continued)<br>FS-1 Chemical Monitoring Network<br>Comprehensive Long-Term Monitoring Plan | | | |
|---|---|---|---|
| **Location** | **Rationale For Monitoring** | **Frequency** | **Parameters** |
| 36EW4139 | Monitor shallow groundwater along the west side of the K6 bog (replacement for 36EW4137). | SA | EDB |
| 36MW0002 | FS-1 plume source area monitoring. | BA | Metals* |
| 36MW0007 | FS-1 plume source area monitoring. | BA | Metals* |
| 36MW0010A | FS-1 plume source area monitoring. | BA | Metals* |
| 36MW0015 | FS-1 plume source area monitoring. | BA | Metals* |
| 36MW0131A | FS-1 interior well. | SA | EDB |
| 36MW0131B | FS-1 interior well. | SA | EDB |
| 36MW0131C | FS-1 interior well. | SA | EDB |
| 36MW0132A | FS-1 leading edge. | SA | EDB |
| 36MW0132B | FS-1 leading edge. | SA | EDB |
| 36MW0132C | FS-1 leading edge. | SA | EDB |
| 36MW0133 | Southeast of the FS-1 leading edge. | A | EDB |
| 36MW0135 | South of the FS-1 leading edge. | SA | EDB |
| 36MW0136 | Southeast of the FS-1 leading edge. | A | EDB |
| 36MW0137 | West boundary of FS-1 plume. | SA | EDB |
| 36MW0138 | Southeast of the FS-1 leading edge, outside plume boundary. | A | EDB |
| 36MW0139 | West of the FS-1 plume, outside plume boundary. | A | EDB |
| 36MW0140 | East of the FS-1 plume, outside plume boundary. | A | EDB |
| 36MW0141 | East of the FS-1 plume, outside plume boundary. | A | EDB |
| 36MW0143 | Southwest of the FS-1 leading edge, outside plume boundary. | A | EDB |
| 36MW0501 | East of the FS-1 plume, outside plume boundary. | A | EDB |
| 36MW0503A | Mid-interior of FS-1 plume. | A | EDB |
| 36MW0503B | Mid-interior of FS-1 plume. | A | EDB |
| 36MW0503C | Mid-interior of FS-1 plume. | A | EDB |
| 36MW0504 | West of the FS-1 plume, outside plume boundary. | A | EDB |
| 36MW0603A | Northern interior of FS-1 plume. | BA | EDB |
| 36MW0603B | Northern interior of FS-1 plume. | BA | EDB |
| 36MW0604 | West of FS-1 plume, outside plume boundary. | BA | EDB |
| 36MW1001A | Interior of FS-1 plume, leading edge. | SA | EDB |
| 36MW1001B | Interior of FS-1 plume, leading edge. | SA | EDB |
| 36MW1003A | Interior of FS-1 plume, leading edge. | SA | EDB |
| 36MW1010A | Interior of FS-1 plume. | SA | EDB |
| 36MW1010B | Interior of FS-1 plume. | SA | EDB |
| 36MW1010C | Interior of FS-1 plume. | SA | EDB |
| 36MW1011A | Southwest of the FS-1 leading edge, outside plume boundary. | A | EDB |

| Table 3-2 (continued)<br>FS-1 Chemical Monitoring Network<br>Comprehensive Long-Term Monitoring Plan | | | |
|---|---|---|---|
| **Location** | **Rationale For Monitoring** | **Frequency** | **Parameters** |
| 36MW1011B | Southwest of the FS-1 leading edge, outside plume boundary. | A | EDB |
| 36MW1012A | Leading edge of FS-1 plume, west side. | SA | EDB |
| 36MW1012B | Leading edge of FS-1 plume, west side. | SA | EDB |
| 36MW1012C | Leading edge of FS-1 plume, west side. | SA | EDB |
| 36MW1013A | East edge of FS-1 plume, outside plume boundary. | A | EDB |
| 36MW1013E | East edge of FS-1 plume, outside plume boundary. | A | EDB |
| 36MW1014A | FS-1 plume, west edge. | SA | EDB |
| 36MW1014B | FS-1 plume, west edge. | SA | EDB |
| 36MW1035 | North of FS-1 Plume, outside plume boundary. | BA | EDB |
| 36MW1036A | Northern interior of FS-1 plume. | BA | EDB |
| 36MW1036B | Northern interior of FS-1 plume. | BA | EDB |
| 36MW1036C | Northern interior of FS-1 plume. | BA | EDB |
| 36MW1038A | Interior of FS-1 plume. | SA | EDB |
| 36MW1038B | Interior of FS-1 plume. | SA | EDB |
| 36MW1038C | Interior of FS-1 plume. | SA | EDB |
| 36MW1039A | FS-1 plume, west edge. | A | EDB |
| 36MW1039B | FS-1 plume, west edge. | A | EDB |
| 36MW1039C | FS-1 plume, west edge. | A | EDB |
| 36MW1040A | FS-1 plume, east edge. | SA | EDB |
| 36MW1040B | FS-1 plume, east edge. | SA | EDB |
| 36MW1041A | FS-1 plume, interior. | SA | EDB |
| 36MW1041B | FS-1 plume, interior. | SA | EDB |
| 36MW1041C | FS-1 plume, interior. | SA | EDB |
| 36MW1042A | North of FS-1 Plume, outside plume boundary. | BA | EDB |
| 36MW1042B | North of FS-1 Plume, outside plume boundary. | BA | EDB |
| 36MW1043A | Monitor the northern interior portion of the FS-1 plume. | BA | EDB |
| 36MW1043B | Monitor the northern interior portion of the FS-1 plume. | BA | EDB |
| 36PZ1001 | Interior of FS-1 plume, leading edge. | SA | EDB |
| 36PZ1002A | West of FS-1 plume, leading edge. | SA | EDB |
| 36PZ1002B | West of FS-1 plume, leading edge. | SA | EDB |
| 36PZ1003 | West boundary of FS-1 plume. | SA | EDB |
| 36PZ1010 | Interior of FS-1 plume. | SA | EDB |
| 36SW0001 | Monitor surface water downstream of the cranberry bogs. | SA | EDB |
| 36SW0003 | Monitor surface water downgradient of treatment system surface discharge, Quashnet River. | Q | EDB |

**Table 3-2 (continued)**
**FS-1 Chemical Monitoring Network**
**Comprehensive Long-Term Monitoring Plan**

| Location | Rationale For Monitoring | Frequency | Parameters |
|---|---|---|---|
| 36SW0007 | Monitor surface water inflowing to the K1 bog. | SA | EDB |
| 36SW0010 | Monitor surface water of the K1 bog discharging to the northern tributary of the Quashnet River (K2 bog west ditch). | SA | EDB |
| 36SW0015 | Monitor surface water of the Quashnet River entering the bogs. | SA | EDB |
| 36SW0019 | Monitor surface water of the K6 bog. | M | EDB |
| 36SW0036 | Monitor surface water of the K6 bog. | Q | EDB |
| 36SW0200 | Monitor surface water of the K2 east ditch. | M | EDB |
| 36SW0201 | Monitor surface water of the K2 bog east ditch. | M | EDB |
| 36SW0221 | Monitor surface water of the K1 bog north ditch. | SA | EDB |
| 36SW0300 | Monitor surface water of the K2 bog west ditch. | Q | EDB |
| 36SW0301 | Monitor surface water of the K2 bog west ditch. | SA | EDB |
| 36SW0302 | Monitor surface water downstream of the treatment system discharge to the K2 bog west ditch. | Q | EDB |
| 36SW0303 | Monitor surface water of the K2 bog east ditch. | M | EDB |
| 36SW4188 | Monitor surface water of the K6 bog. | M | EDB |
| 36SW0007 | Monitor surface water inflowing to the K1 bog. | SA | EDB |
| 36SW0010 | Monitor surface water of the K1 bog discharging to the northern tributary of the Quashnet River (K2 bog west ditch). | SA | EDB |

Data Source: July 2004, MMR-AFCEE Data Warehouse

Note: Analytical sampling methods for the specified parameters: VOC (SW846 8260B); EDB (EPA 504.1); metals (SW846 6010/7000 series).

Key:
DO = dissolved oxygen
EDB = ethylene dibromide
FS-1 = Fuel Spill-1
ft msl = feet mean sea level
Hr = hourly
WL = water level
N/A = not applicable
A = annually
BA = biennial; once every two years
Q = quarterly
SA = semiannually
SG = stream gauging
M = monthly
VOCs = volatile organic compounds

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| Table 3-3<br>FS-1 Hydraulic Monitoring Network<br>Comprehensive Long-Term Monitoring Plan | | | |
|---|---|---|---|
| **Location** | **Rationale For Monitoring** | **Frequency** | **Parameters** |
| 00MW0552A | South of the FS-1 leading edge, outside plume boundary. | SA | WL |
| 00MW0552B | South of the FS-1 leading edge, outside plume boundary. | SA | WL |
| 00MW0552C | South of the FS-1 leading edge, outside plume boundary. | SA | WL |
| 00MW0552D | South of the FS-1 leading edge, outside plume boundary. | SA | WL |
| 36MW0132A | FS-1 leading edge. | SA | WL |
| 36MW0132B | FS-1 leading edge. | SA | WL |
| 36MW0132C | FS-1 leading edge. | SA | WL |
| 36MW0133 | Southeast of the FS-1 leading edge. | SA | WL |
| 36MW0136 | Southeast of the FS-1 leading edge. | SA | WL |
| 36MW0138 | Southeast of the FS-1 leading edge, outside plume boundary. | SA | WL |
| 36MW0139 | West of the FS-1 plume, outside plume boundary. | SA | WL |
| 36MW0140 | East of the FS-1 plume, outside plume boundary. | SA | WL |
| 36MW0141 | East of the FS-1 plume, outside plume boundary. | SA | WL |
| 36MW0501 | East of the FS-1 plume, outside plume boundary. | SA | WL |
| 36MW0503A | Mid-interior of FS-1 plume. | SA | WL |
| 36MW0503B | Mid-interior of FS-1 plume. | SA | WL |
| 36MW0503C | Mid-interior of FS-1 plume. | SA | WL |
| 36MW0504 | West of the FS-1 plume, outside plume boundary. | SA | WL |
| 36MW0603A | Northern interior of FS-1 plume. | SA | WL |
| 36MW0603B | Northern interior of FS-1 plume. | SA | WL |
| 36MW1010A | Interior of FS-1 plume. | SA | WL |
| 36MW1010B | Interior of FS-1 plume. | SA | WL |
| 36MW1010C | Interior of FS-1 plume. | SA | WL |
| 36MW1011A | Southwest of the FS-1 leading edge, outside plume boundary. | SA | WL |
| 36MW1011B | Southwest of the FS-1 leading edge, outside plume boundary. | SA | WL |
| 36MW1013A | East edge of FS-1 plume, outside plume boundary. | SA | WL |
| 36MW1013B | East edge of FS-1 plume, outside plume boundary. | SA | WL |
| 36MW1013C | East edge of FS-1 plume, outside plume boundary. | SA | WL |
| 36MW1013D | East edge of FS-1 plume, outside plume boundary. | SA | WL |
| 36MW1013E | East edge of FS-1 plume, outside plume boundary. | SA | WL |
| 36MW1036A | Northern interior of FS-1 plume. | SA | WL |
| 36MW1036B | Northern interior of FS-1 plume. | SA | WL |
| 36MW1036C | Northern interior of FS-1 plume. | SA | WL |

| Table 3-3 (continued)<br>FS-1 Hydraulic Monitoring Network<br>Comprehensive Long-Term Monitoring Plan | | | |
|---|---|---|---|
| **Location** | **Rationale For Monitoring** | **Frequency** | **Parameters** |
| 36MW1038A | Interior of FS-1 plume. | SA | WL |
| 36MW1038B | Interior of FS-1 plume. | SA | WL |
| 36MW1038C | Interior of FS-1 plume. | SA | WL |
| 36MW1040A | FS-1 plume, east edge. | SA | WL |
| 36MW1040B | FS-1 plume, east edge. | SA | WL |
| 36MW1041A | FS-1 plume, interior. | SA | WL |
| 36MW1041B | FS-1 plume, interior. | SA | WL |
| 36MW1041C | FS-1 plume, interior. | SA | WL |
| 36MW1044A | FS-1 plume, interior. | SA | WL |
| 36MW1044B | FS-1 plume, interior. | SA | WL |
| 36PZ1010 | Interior of FS-1 plume. | SA | WL |
| 36PZ4235 | Monitor shallow groundwater in the vicinity of the vernal pool southeast of 36EW0007. | M | WL |
| 36PZ4236 | Monitor shallow groundwater in the vicinity of the wetland north of Grafton Pocknet Road. | M | WL |
| 36PZ4237 | Monitor shallow groundwater in the vicinity of the wetland east of the K1 bog. | M | WL |

Key:
FS-1 = Fuel Spill-1
M = monthly
SA = semiannually
WL = water level

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**Table 3-4**
**FS-1 Groundwater Monitoring Well and Surface Water Monitoring Point Information**
**Comprehensive Long-Term Monitoring Plan**

| Location | Northing (ft) | Easting (ft) | Surface Elevation (ft msl) | Total Depth (ft bgs) | TOC Elevation (ft msl) | Top Screen Elevation (ft msl) | Bottom Screen Elevation (ft msl) | Screen Length (ft) |
|---|---|---|---|---|---|---|---|---|
| 00MW0552A | 232375 | 871964 | 37.2 | 120 | 40.03 | -77.8 | -82.8 | 5 |
| 00MW0552B | 232369 | 871968 | 36.92 | 89 | 39.29 | -47.08 | -52.08 | 5 |
| 00MW0552C | 232385 | 871955 | 38.22 | 64 | 39.77 | -20.78 | -25.78 | 5 |
| 00MW0552D | 232380 | 871961 | 37.4 | 14 | 39.7 | 33.4 | 23.4 | 10 |
| 36EW0001[1] | 233941.05 | 871784.01 | 56.76 | 205 | 49.52 | -4.9 | -129.05 | 100.71 |
| 36EW0005 | 234602.81 | 872017.38 | 37.62 | 194 | 38.36 | -86.68 | -148.38 | 61.7 |
| 36EW0007[2] | 234616.77 | 872541.03 | 46.29 | 205 | 39.1 | -97.72 | -134.85 | 30.4 |
| 36EW0011[3] | 235253.87 | 872495.52 | 93.51 | 255 | 86.39 | -88.66 | -150.65 | 48.16 |
| 36EW4010 | 234467.02 | 871814.55 | 35.72 | 20.75 | 35.97 | 18.22 | 15.22 | 3 |
| 36EW4020 | 234367.61 | 871811.5 | 36.19 | 21.27 | 36.44 | 19.19 | 16.19 | 3 |
| 36EW4035 | 234218.4 | 871804.93 | 36.82 | 21.25 | 37.07 | 18.82 | 15.82 | 3 |
| 36EW4046 | 234141.38 | 871734 | 36.62 | 19.75 | 36.87 | 20.12 | 17.12 | 3 |
| 36EW4054 | 234091.26 | 871672.84 | 35.92 | 19.75 | 36.17 | 19.42 | 16.42 | 3 |
| 36EW4065 | 233984.34 | 871670.88 | 35.78 | 19.25 | 36.03 | 19.78 | 16.78 | 3 |
| 36EW4074 | 233897.37 | 871689.76 | 35.4 | 19.75 | 35.65 | 18.9 | 15.9 | 3 |
| 36EW4084 | 233801.32 | 871669.92 | 35.14 | 20.75 | 35.39 | 17.64 | 14.64 | 3 |
| 36EW4090 | 233754.35 | 871636.09 | 34.5 | 21.25 | 34.75 | 16.5 | 13.5 | 3 |
| 36EW4100 | 233697.37 | 871554.19 | 34.22 | 19.75 | 34.47 | 17.72 | 14.72 | 3 |
| 36EW4132 | 233690.6 | 871838.44 | 35.24 | 20.73 | 35.49 | 18.24 | 15.24 | 3 |
| 36EW4135 | 233665.22 | 871853.9 | 34.38 | 20.25 | 34.63 | 17.38 | 14.38 | 3 |
| 36EW4137 | 233706.74 | 871629 | 30.69 | 13.54 | 32.44 | 20.48 | 17.15 | 3.33 |
| 36EW4149 | 233635.63 | 871532.82 | 29.74 | 13.54 | 32.72 | 19.53 | 16.2 | 3.33 |
| 36MW0001 | 241997 | 870723 | 106.07 | 53.3 | 109.27 | 62.8 | 52.8 | 10 |
| 36MW0002 | 241852 | 870832 | 105.75 | 56.5 | 108.75 | 59.29 | 49.29 | 10 |
| 36MW0007 | 241934 | 870793 | 107.2 | 56 | 110.14 | 61.2 | 51.2 | 10 |
| 36MW0010A | 241336 | 871045 | 108.1 | 75 | 110.92 | 38.1 | 33.1 | 5 |
| 36MW0011 | 240695 | 871917 | 115.1 | 75 | 117.67 | 45.4 | 40.4 | 5 |
| 36MW0015 | 241917 | 870759 | 106.6 | 130.9 | 108.8 | -19.25 | -24.25 | 5 |
| 36MW0131A | 234439.92 | 872235.61 | 52.15 | 185.6 | 54.39 | -127.85 | -132.85 | 5 |
| 36MW0131B | 234439.51 | 872228.36 | 53.37 | 139.4 | 55.25 | -80.63 | -85.63 | 5 |
| 36MW0131C | 234439.31 | 872228.4 | 53.37 | 90 | 55.3 | -31.63 | -36.63 | 5 |
| 36MW0132A | 233921.7 | 871753.9 | 54.3 | 190 | 53.96 | -130.7 | -135.7 | 5 |
| 36MW0132B | 233921.6 | 871753.9 | 54.3 | 140 | 53.96 | -80.7 | -85.7 | 5 |
| 36MW0132C | 233936 | 871753.8 | 54.61 | 83 | 53.98 | -23.39 | -28.39 | 5 |
| 36MW0133 | 233262.4 | 871814.6 | 34.04 | 60 | 33.82 | -20.96 | -25.96 | 5 |

**Table 3-4 (continued)**
**FS-1 Groundwater Monitoring Well and Surface Water Monitoring Point Information**
**Comprehensive Long-Term Monitoring Plan**

| Location | Northing (ft) | Easting (ft) | Surface Elevation (ft msl) | Total Depth (ft bgs) | TOC Elevation (ft msl) | Top Screen Elevation (ft msl) | Bottom Screen Elevation (ft msl) | Screen Length (ft) |
|---|---|---|---|---|---|---|---|---|
| 36MW0135 | 233627.6 | 871320.1 | 34.48 | 180 | 34.26 | -140.52 | -145.52 | 5 |
| 36MW0136 | 233717.3 | 872068.8 | 55.74 | 150.5 | 58.52 | -89.74 | -94.26 | 4.52 |
| 36MW0137 | 235102.6 | 871873.39 | 58.34 | 111.7 | 60.51 | -47.66 | -52.66 | 5 |
| 36MW0138 | 233552.7 | 872185.4 | 57.03 | 152 | 59.96 | -89.97 | -94.97 | 5 |
| 36MW0139 | 235174.52 | 871637.83 | 47.37 | 100 | 49.58 | -47.63 | -52.63 | 5 |
| 36MW0140 | 234664.7 | 872715.1 | 50.44 | 140 | 50.16 | -84.56 | -89.56 | 5 |
| 36MW0141 | 235522.1 | 873857.7 | 95.3 | 220 | 97.21 | -119.7 | -124.7 | 5 |
| 36MW0143 | 233279.2 | 871160.9 | 34.94 | 170 | 34.68 | -130.06 | -135.06 | 5 |
| 36MW0501 | 237066.31 | 872993.51 | 78.38 | 150 | 78.03 | -66.62 | -71.62 | 5 |
| 36MW0503A | 236911.44 | 872331.03 | 103.21 | 195 | 102.97 | -86.79 | -91.79 | 5 |
| 36MW0503B | 236913.42 | 872337.26 | 103.1 | 150 | 102.64 | -41.9 | -46.9 | 5 |
| 36MW0503C | 236913.84 | 872343 | 102.87 | 120 | 102.64 | -12.13 | -17.13 | 5 |
| 36MW0504 | 236799.15 | 871835.56 | 78.85 | 182 | 78.46 | -98.15 | -103.15 | 5 |
| 36MW0603A | 239410.86 | 871954.33 | 110.68 | 200 | 110.45 | -84.32 | -89.32 | 5 |
| 36MW0603B | 239406.93 | 871949.72 | 110.63 | 150 | 110.42 | -34.37 | -39.37 | 5 |
| 36MW0604 | 239187 | 871643 | 112.08 | 200 | 111.88 | -82.92 | -87.92 | 5 |
| 36MW1001A | 233707.19 | 871589.22 | 34.48 | 185 | 33.36 | -110.52 | -115.52 | 5 |
| 36MW1001B | 233701.23 | 871582.1 | 34.63 | 185 | 34.13 | -60.37 | -65.37 | 5 |
| 36MW1003A | 234669.74 | 871920.23 | 36.49 | 216 | 36.1 | -112.61 | -117.61 | 5 |
| 36MW1010A | 234895.77 | 872068.36 | 49.37 | 253 | 51.62 | -171.13 | -181.13 | 10 |
| 36MW1010B | 234921.5 | 872071.15 | 50.63 | 167 | 49.95 | -109.37 | -114.37 | 5 |
| 36MW1010C | 234895.7 | 872068.3 | 49.37 | 253 | 51.64 | -31.13 | -36.13 | 5 |
| 36MW1011A | 233119.52 | 871376.33 | 34.62 | 232 | 33.88 | -60.38 | -65.38 | 5 |
| 36MW1011B | 233130.98 | 871367.92 | 34.84 | 27 | 34.45 | 14.84 | 9.84 | 5 |
| 36MW1012A | 234297.74 | 871823.75 | 38.04 | 196 | 37.24 | -106.06 | -111.06 | 5 |
| 36MW1012B | 234304.08 | 871825.21 | 38.1 | 80 | 37.64 | -34.8 | -39.8 | 5 |
| 36MW1012C | 234303.76 | 871825.34 | 38.1 | 80 | 37.72 | 20.5 | 15.5 | 5 |
| 36MW1013A | 234163.98 | 872713.25 | 56.91 | 234 | 59.17 | -107.89 | -112.89 | 5 |
| 36MW1013B | 234164.28 | 872713.42 | 56.91 | 234 | 59.29 | -67.69 | -72.69 | 5 |
| 36MW1013C | 234155.06 | 872713.35 | 57.38 | 40 | 58.25 | 27.38 | 22.38 | 5 |
| 36MW1013D | 234167.48 | 872701.76 | 57.45 | 315 | 56.89 | -166.78 | -171.78 | 5 |
| 36MW1013E | 234167.93 | 872701.76 | 57.45 | 315 | 56.88 | -131.72 | -136.72 | 5 |
| 36MW1014A | 234611.39 | 871830.02 | 36.37 | 195 | 36.17 | -57.13 | -62.13 | 5 |
| 36MW1014B | 234607.26 | 871829.09 | 36.16 | 25 | 35.98 | 18.06 | 13.06 | 5 |
| 36MW1035 | 239981.74 | 871823.28 | 114.23 | 283 | 113.8 | -73.27 | -78.27 | 5 |
| 36MW1036A | 238792.81 | 872114.21 | 107.97 | 351 | 107.37 | -150.03 | -154.98 | 4.95 |

**Table 3-4 (continued)**
**FS-1 Groundwater Monitoring Well and Surface Water Monitoring Point Information**
**Comprehensive Long-Term Monitoring Plan**

| Location | Northing (ft) | Easting (ft) | Surface Elevation (ft msl) | Total Depth (ft bgs) | TOC Elevation (ft msl) | Top Screen Elevation (ft msl) | Bottom Screen Elevation (ft msl) | Screen Length (ft) |
|---|---|---|---|---|---|---|---|---|
| 36MW1036B | 238790 | 872104.5 | 107.85 | 294 | 107.09 | -111.05 | -116.05 | 5 |
| 36MW1036C | 238793.08 | 872114.6 | 107.97 | 351 | 107.37 | -62.18 | -67.13 | 4.95 |
| 36MW1038A | 235573.02 | 872357.38 | 96.76 | 321 | 96.56 | -142.94 | -147.84 | 4.9 |
| 36MW1038B | 235566.69 | 872349.57 | 96.95 | 252 | 96.18 | -102.15 | -106.95 | 4.8 |
| 36MW1038C | 235578.12 | 872363.05 | 96.55 | 100 | 96.05 | 7.45 | 2.65 | 4.8 |
| 36MW1039A | 236725.69 | 872097.18 | 101.43 | 275 | 100.97 | -147.04 | -151.99 | 4.95 |
| 36MW1039B | 236714.86 | 872099.58 | 101.55 | 264 | 101.14 | -87.45 | -92.45 | 5 |
| 36MW1039C | 236725.68 | 872096.9 | 101.43 | 275 | 100.96 | -37.53 | -42.48 | 4.95 |
| 36MW1040A | 235647.79 | 872945.2 | 64.54 | 234 | 64.32 | -149.18 | -153.98 | 4.8 |
| 36MW1040B | 235646.76 | 872953.29 | 64.49 | 136 | 64.19 | -63.99 | -68.82 | 4.83 |
| 36MW1041A | 235745.02 | 872658.51 | 93.88 | 236 | 93.12 | -125.22 | -130.02 | 4.8 |
| 36MW1041B | 235744.77 | 872650.21 | 93.95 | 311 | 93.52 | -55.75 | -60.65 | 4.9 |
| 36MW1041C | 235744.69 | 872650.07 | 93.95 | 311 | 93.51 | -35.85 | -40.75 | 4.9 |
| 36MW1042A | 239060.4 | 872473.36 | 108.38 | 285 | 108.16 | -111.5 | -116.45 | 4.95 |
| 36MW1042B | 239066.98 | 872476.96 | 108.65 | 216 | 107.87 | -70.45 | -75.25 | 4.8 |
| 36MW1043A | 237499.64 | 872398.73 | 104.58 | 305 | 104.23 | -145.4 | -150.19 | 4.79 |
| 36MW1043B | 237499.47 | 872398.69 | 104.58 | 305 | 104.23 | -55.26 | -60.38 | 5.12 |
| 36PZ1001 | 233707.29 | 871589.35 | 33.9 | 185 | 33.36 | 31.9 | 26.9 | 5 |
| 36PZ1002A | 234085.61 | 871663.96 | 33.74 | 200 | 33.46 | -91.26 | -96.26 | 5 |
| 36PZ1002B | 234085.78 | 871663.91 | 33.74 | 200 | 33.62 | 31.74 | 26.74 | 5 |
| 36PZ1003 | 234669.64 | 871920.21 | 36.72 | 216 | 36.44 | 34.72 | 29.72 | 5 |
| 36PZ1010 | 234895.62 | 872068.53 | 49.37 | 253 | 51.64 | 24.37 | 19.37 | 5 |
| 36PZ4235 | 234365.22 | 872383.36 | 37.53 | 7.66 | 40.38 | 37.18 | 34.21 | 2.97 |
| 36PZ4236 | 235025.81 | 872099.49 | 39.77 | 7.31 | 43.07 | 36.78 | 33.8 | 2.98 |
| 36PZ4237 | 234604.57 | 872230.96 | 33.53 | 7.32 | 36.48 | 32.51 | 30.51 | 2 |
| 36SW0001 | 232357.3 | 871885.6 | 28.61 | NA | NA | NA | NA | NA |
| 36SW0003 | 233475.6 | 871262.04 | 28.6 | NA | NA | NA | NA | NA |
| 36SW0007 | 234617.6 | 872201.8 | 32.1* | NA | NA | NA | NA | NA |
| 36SW0010 | 234672.19 | 871840.22 | 31.07 | NA | NA | NA | NA | NA |
| 36SW0015 | 233577.22 | 870655.98 | 30.2 | NA | NA | NA | NA | NA |
| 36SW0019 | 233070 | 871579 | 29.48 | NA | NA | NA | NA | NA |
| 36SW0036 | 233742.83 | 871662.52 | 36.4 | NA | NA | NA | NA | NA |
| 36SW0200 | 233487.89 | 871316.75 | 29.92 | NA | NA | NA | NA | NA |
| 36SW0201 | 233611.06 | 871282.86 | 30.33 | NA | NA | NA | NA | NA |
| 36SW0221 | 234696.83 | 871829.97 | 31.97 | NA | NA | NA | NA | NA |
| 36SW0300 | 234684.72 | 871788.07 | 32.48 | NA | NA | NA | NA | NA |

**Table 3-4 (continued)**
**FS-1 Groundwater Monitoring Well and Surface Water Monitoring Point Information**
**Comprehensive Long-Term Monitoring Plan**

| Location | Northing (ft) | Easting (ft) | Surface Elevation (ft msl) | Total Depth (ft bgs) | TOC Elevation (ft msl) | Top Screen Elevation (ft msl) | Bottom Screen Elevation (ft msl) | Screen Length (ft) |
|---|---|---|---|---|---|---|---|---|
| 36SW0301 | 234645.85 | 871792.93 | 32.99 | NA | NA | NA | NA | NA |
| 36SW0302 | 234440.58 | 871337.35 | 30.82 | NA | NA | NA | NA | NA |
| 36SW0303 | 234099.45 | 871643.97 | 30.16 | NA | NA | NA | NA | NA |
| 36SW4188 | 233176.08 | 871721.09 | 31.53 | NA | NA | NA | NA | NA |

Data Source: AFCEE, May 2004, MMR-AFCEE Data Warehouse

Key:
bgs = below ground surface
ft = feet
msl = mean sea level
NA = not applicable
TOC = top of casing
* = estimated data
[1] = there is no screen from -80 to -103.5 ft msl
[2] = there is no screen from -114 to -120.7 ft msl
[3] = there is no screen from -130.7 to -144.6 ft msl

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In-plant monitoring is performed to: (1) assess the contaminant removal efficiency during the treatment process; (2) assess potential human health risks and ecological impacts associated with the discharge of treated groundwater to the Quashnet River and associated bogs; and (3) verify that the treatment system effluent meets the requirements stated in the discharge permit. The monitoring activities include chemical analyses and measurement of water quality parameters of the influent and process-stream water at selected locations in the plant. Refer to **Table 3-5** for treatment plant sampling location information, sampling frequency, and parameters measured. Refer to **Figure 3-4** for sampling locations in the treatment plant.

First, second, and third quarter data summaries are presented during the technical update meeting with the regulatory agencies. A comprehensive system performance and ecological impact assessment is included in each report. Refer to **Table 3-6** for recent updates to the monitoring program.

| Table 3-5<br>FS-1 Treatment System Sampling Information<br>Comprehensive Long-Term Monitoring Plan | | |
|---|---|---|
| **Location** | **Frequency** | **Parameters** |
| FS-1 plant influent (36PLT02001) | M | EDB |
| FS-1 Post-GAC 1A (36PLT02002) | M | EDB |
| FS-1 Post-GAC 1B (36PLT02003) | M | EDB |
| FS-1 Post-GAC 1C (36PLT02004) | M | EDB |
| FS-1 plant effluent (36PLT02005) | M | EDB |

Note: Due to the versatility of the GAC configuration, any of the GAC units can be located in any of the three positions: lead, intermediate, and lag. Sampling occurs monthly after the lead and lag vessels only.

Key:
EDB = ethylene Dibromide
FS-1 = Fuel Spill-1
GAC = granular activated carbon
M = monthly

## 4.0 CHRONOLOGY OF EVENTS

**Table 4-1** provides a tabular summary that lists the major events for the FS-1 groundwater plume and source area action. The table includes significant milestones and dates, such as report submittal dates and treatment system startup dates. Significant milestones regarding construction activities can be found in **Table 3-1**.

**Table 4-1**
**Chronology of Events for AOC FS-1**

| DATE | EVENT |
|---|---|
| August 1996 | EDB first detected in Quashnet River area surface water. |
| March 1991 | *Draft Remedial Investigation Report AVGAS Fuel Valve Test Dump Site FS-1 Study Area* |
| September 1995 | *Technical Memorandum, Site Investigation for Area of Contamination Fuel Spill 1 and Downgradient Areas.* |
| November 1998 | *Final Ethylene Dibromide: Derivation of Aquatic Screening Benchmarks* |
| April 1999 | FS-1 Pilot Scale system startup |
| May 1999 | *Remedial Investigation Report Area of Contamination FS-1* |
| May 1999 | *Feasibility Study FS-1* |
| September 1999 | *Final Quashnet River and Bogs Pilot Test Monitoring Plan at MMR* |
| April 2000 | *Record of Decision Area of Contamination FS-1* |
| December 2000 | *Final Quashnet River and Bogs System Pilot Test 2000 Annual Report* |
| December 2001 | *Final Fuel Spill 1 Wellfield Design Report* |
| February 2002 | *Final Quashnet River and Bogs 2001 Annual System Performance and Ecological Impact Monitoring Report* |
| April 2002 | *Mashpee Conservation Commission WPA Form 5 - Amended Order of Conditions, Project File Number: SE 43-1761* |
| October 2002 | Shutdown of FS-1 Pilot Scale system due to fire |
| January 2003 | *Project Note: Changes to the FS-1 SPEIM Program* |
| February 2003 | *Final Fuel Spill-1 2002 Annual System Performance and Ecological Impact Monitoring Report* |
| October 2003 | FS-1 Treatment Plant Startup |
| March 2004 | *Final Fuel Spill-1 2003 Annual System Performance and Ecological Impact Monitoring Report* |
| September 2004 | *Fuel Spill 1 Groundwater Treatment System Operation and Maintenance Manual* |

# 5.0 PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

Performance standards and construction quality control information for the FS-1 treatment system will be reported and evaluated as part of the Fuel Spill-1 Treatment System 2004 SPEIM Report. The 2004 SPEIM report, scheduled for distribution in February 2005, covers the FS-1 treatment system monitoring period from May 2003 through August 2004 and includes evaluations of the treatment plant and monitoring systems. It also includes an evaluation of the remedial system and various optimization recommendations and presents conclusions that were not available for inclusion in this FS-1 Interim Remedial Action Report.

## 5.1 Overall Performance and Cleanup Goals

The overall performance and cleanup goals of the FS-1 remedial system are evaluated via the SPEIM program. The SPEIM program for the FS-1 remedial system is designed to meet the following objectives: assess contaminant mass removal for the FS-1 plume; identify plume boundary migration and contaminant trends upgradient and downgradient of the remedial system; optimize operation of the remedial system; provide information on hydrology and contaminant distribution required to update the groundwater model; conduct performance assessment and optimization modeling of the groundwater remedial systems; and evaluate the timeframe required for remediation to be completed.

## 5.2 Material Treated and Data Collection

### 5.2.1 Material Treated

The FS-1 treatment systems have been and continue to be effective in capturing FS-1 contaminated groundwater. The Quashnet River and Bogs Pilot Test treated approximately 1,237 million gallons of contaminated groundwater and removed 10.9 pounds of EDB from April 1999 to October 2002 when a fire destroyed the treatment plant. During the time period from November 2002 through September 2003, while the new FS-1 ETD system was being constructed, all applicable SPEIM monitoring activities were conducted; however, no groundwater was treated. As of October 2004 the FS-1 ETD system, which began operation in October 2003, has treated approximately 318 million gallons of contaminated groundwater while removing 3.97 pounds of EDB. Thus, the total volume of groundwater treated by the FS-1 treatment systems from April 1999 through October 2004 was approximately 1,555 million gallons and the total amount of EDB removed from the plume was 14.87 pounds. This represents approximately 70% of the total estimated mass of EDB contained within the FS-1 plume. **Table 5-1** presents the monthly and total volume of groundwater treated and EDB removed by the Quashnet River and Bogs pilot test and the FS-1 Extraction Treatment and Discharge system.

| Table 5-1<br>Groundwater Treatment Statistics for FS-1 Treatment Systems<br>Monthly and Total Volume of Groundwater Processed and<br>Total Contaminant Mass Removed | | | | |
|---|---|---|---|---|
| **Month** | **Increment for Period** | | **Running Totals** | |
| | **Total Groundwater Volume (Mgal)** | **Total EDB Mass Removed (lbs)** | **GW Volume (Mgal)** | **EDB Mass Removed (lbs)** |
| Startup of Quashnet River and Bogs Pilot Test | | | | |
| Apr-99 | 5.3 | 0.1 | 5.3 | 0.1 |
| May-99 | 27.7 | 0.6 | 33.0 | 0.7 |
| Jun-99 | 27.6 | 0.5 | 60.5 | 1.2 |
| Jul-99 | 27.9 | 0.5 | 88.4 | 1.7 |
| Aug-99 | 27.5 | 0.7 | 115.8 | 2.4 |
| Sep-99 | 25.3 | 0.4 | 141.2 | 2.8 |
| Oct-99 | 25.9 | 0.34 | 167.0 | 3.1 |
| Nov-99 | 27.48 | 0.39 | 194.5 | 3.5 |
| Dec-99 | 29.0 | 0.4 | 223.5 | 3.9 |
| Jan-00 | 29 | 0.2 | 252.6 | 4.2 |
| Feb-00 | 25.6 | 0.2 | 278.1 | 4.4 |
| Mar-00 | 28.4 | 0.4 | 306.5 | 4.7 |
| Apr-00 | 27.9 | 0.4 | 334.5 | 5.1 |
| May-00 | 27 | 0.2 | 361.5 | 5.3 |
| Jun-00 | 27.6 | 0.3 | 389.1 | 5.6 |
| Jul-00 | 28.4 | 0.4 | 417.5 | 5.9 |
| Aug-00 | 28.4 | 0.2 | 445.9 | 6.1 |
| Sep-00 | 26.3 | 0.2 | 472.2 | 6.3 |
| Oct-00 | 28.9 | 0.3 | 501.1 | 6.6 |
| Nov-00 | 27.9 | 0.2 | 529.0 | 6.8 |
| Dec-00 | 28.9 | 0.2 | 557.9 | 7.0 |
| Jan-01 | 29 | 0.2 | 586.9 | 7.1 |
| Feb-01 | 27.1 | 0.1 | 614.0 | 7.3 |
| Mar-01 | 32.9 | 0.2 | 646.8 | 7.5 |
| Apr-01 | 31.5 | 0.2 | 678.4 | 7.7 |
| May-01 | 32.2 | 0.2 | 710.6 | 7.9 |
| Jun-01 | 32.2 | 0.1 | 742.7 | 8.1 |
| Jul-01 | 33.7 | 0.2 | 776.4 | 8.3 |
| Aug-01 | 32.6 | 0.2 | 809.0 | 8.6 |
| Sep-01 | 31.6 | 0.1 | 840.5 | 8.7 |
| Oct-01 | 33 | 0.1 | 873.5 | 8.9 |
| Nov-01 | 29.7 | 0.2 | 903.3 | 9.1 |
| Dec-01 | 32.9 | 0.2 | 936.2 | 9.3 |
| Jan-02 | 33.1 | 0.1 | 969.3 | 9.5 |
| Feb-02 | 29.7 | 0.1 | 999.0 | 9.6 |

**Table 5-1 (continued)**
**Groundwater Treatment Statistics for FS-1 Treatment Systems**
**Monthly and Total Volume of Groundwater Processed and**
**Total Contaminant Mass Removed**

| Month | Increment for Period | | Running Totals | |
|---|---|---|---|---|
| | Total Groundwater Volume (Mgal) | Total EDB Mass Removed (lbs) | GW Volume (Mgal) | EDB Mass Removed (lbs) |
| Mar-02 | 32.8 | 0.1 | 1031.8 | 9.8 |
| Apr-02 | 31.6 | 0.1 | 1063.4 | 9.93 |
| May-02 | 32.2 | 0.2 | 1095.6 | 10.10 |
| Jun-02 | 31.3 | 0.1 | 1126.9 | 10.27 |
| Jul-02 | 32.8 | 0.1 | 1159.7 | 10.44 |
| Aug-02 | 32.1 | 0.2 | 1191.8 | 10.63 |
| Sep-02 | 31.3 | 0.2 | 1223.2 | 10.84 |
| Oct-02 | 13.8 | 0.1 | 1236.9 | 10.90 |
| Shutdown of Quashnet River and Bogs Pilot Test (due to fire) | | | | |
| Nov-02 | 0.0 | 0.0 | 1236.9 | 10.90 |
| Dec-02 | 0.0 | 0.0 | 1236.9 | 10.90 |
| Jan-03 | 0.0 | 0.0 | 1236.9 | 10.90 |
| Feb-03 | 0.0 | 0.0 | 1236.9 | 10.90 |
| Mar-03 | 0.0 | 0.0 | 1236.9 | 10.90 |
| Apr-03 | 0.0 | 0.0 | 1236.9 | 10.90 |
| May-03 | 0.0 | 0.0 | 1236.9 | 10.90 |
| Jun-03 | 0.0 | 0.0 | 1236.9 | 10.90 |
| Jul-03 | 0.0 | 0.0 | 1236.9 | 10.90 |
| Aug-03 | 0.0 | 0.0 | 1236.9 | 10.90 |
| Sep-03 | 0.0 | 0.0 | 1236.9 | 10.90 |
| Startup of FS-1 Extraction Treatment Discharge System | | | | |
| Oct-03 | 15.4 | 0.19 | 1252.3 | 11.09 |
| Nov-03 | 25.8 | 0.43 | 1278.1 | 11.52 |
| Dec-03 | 32.2 | 0.46 | 1310.2 | 11.98 |
| Jan-04 | 32.8 | 0.41 | 1343.0 | 12.39 |
| Feb-04 | 30.3 | 0.35 | 1373.3 | 12.74 |
| Mar-04 | 33.4 | 0.35 | 1406.7 | 13.09 |
| Apr-04 | 18.1 | 0.19 | 1424.8 | 13.28 |
| May-04 | 28.1 | 0.26 | 1452.9 | 13.55 |
| Jun-04 | 32.3 | 0.29 | 1485.2 | 13.84 |
| Jul-04 | 33.4 | 0.28 | 1518.6 | 14.12 |
| Aug-04 | 33.5 | 0.26 | 1552.1 | 14.39 |
| Sep-04 | 32.4 | 0.25 | 1584.5 | 14.64 |
| Oct-04 | 33.4 | 0.23 | 1617.9 | 14.87 |

### 5.2.2 Data Collection and Assessment

The following provides methods for collecting analytical data, assessing system performance, and assessing ecosystems for the FS-1 remedial system SPEIM report. Results of all sampling and analyses efforts completed for the FS-1 Pilot Test are documented in periodic SPEIM reports. These documents are listed on the MMR website and also provided in **Table 4-1**. Many of these documents include Data Summary Reports which analyze the data using standard QA/QC measures.

Remedial system performance monitoring includes assessing the extraction and discharge systems and their influence on the aquifer and in plume characteristics. It includes both hydraulic monitoring (i.e. groundwater elevation and flow direction, horizontal/vertical gradients) and discharge impact monitoring (hydraulic and water quality impact of the reinjected water on surface water). EDB concentrations are measured monthly at each extraction well. These concentrations are used for both mass removal calculations and design optimization considerations. Extraction well flow rates are measured individually at each extraction well and the combined flow rate is measured at the treatment plant at the sampling location 36PLT02001 (see Figure 3-4). This information is presented in the 2004 FS-1 SPEIM report which is scheduled for publication in the spring of 2005.

FS-1 treatment plant performance monitoring consists of the collection and interpretation of treatment plant analytical data in order to monitor treatment plant efficiency. Treatment plant performance monitoring is used to evaluate the treatment effectiveness (contaminant removal) and to return treated water that is similar in groundwater chemistry to the environment. Performance monitoring also includes plant direct impact monitoring where select upgradient monitoring wells are monitored monthly for physicochemical parameters and micronutrients to determine the impacts of the treatment system on these parameters.

## 5.3 Construction Quality Assurance and Quality Control (QA/QC)

All activities associated with the construction, operation, and monitoring of the FS-1 remedial system were performed in accordance with practices and procedures as detailed in the Quality Program Plan (QPP), which contains the Health and Safety Plan (HSP), the Sampling and Analysis Plan (SAP), and the Construction Quality Plan (CQP). The CQP detailed quality-control activities that were to be carried out during construction and ensured that completed work met or exceeded design criteria, plans, and specifications so that all quality objectives were met. Any problems or deviations were addressed through nonconformance reports that documented the details in order to remedy the problem.

Not only were the contractors responsible for ensuring that QA/QC procedures were followed, but also AFCEE provided in-house as well as Title II services for construction oversight. **Appendix A** presents the Pre-Final Inspection (Project Punch List dated November 6, 2003 Attached) for construction of the FS-1 treatment system.

## 5.4 Data QA/QC and Data Quality Objectives (DQOs)

### 5.4.1 Data QA/QC

The MMR QPP was developed in accordance with USEPA New England, Region I Compendium of Quality Assurance Project Plan Guidance (September 1998 Draft Final) and is intended for use as a generic program-wide document. This generic QPP combines all the elements of AFCEE's Model Field Sampling Plan (version 1.1) and the *AFCEE Quality Assurance Project Plan* (version 3.0) into one document. Two appendices are also included: Appendix 3-A, Index of Chemical Methods, and Appendix 3-B, Technical Procedures.

This QPP is applicable to all work performed at MMR on behalf of AFCEE. It outlines the program's quality objectives, and describes a comprehensive set of sampling, analysis, QA/QC, data validation, and assessment guidelines. Although generic in content, specific requirements are established that must be acknowledged prior to conducting work at MMR. Project- or task-specific information not covered by this QPP must be documented in project-specific planning documents.

### 5.4.2 Data Quality Objectives

A systematic project planning process results in DQOs that ensure that the correct type, quality, and quantity of data are collected for the respective investigation. DQOs ensure that the proper data are collected and generated to answer environmental questions regarding a specific environmental problem. Environmental monitoring activities at MMR have been divided into numerous categories: risk management monitoring including monitoring residential wells and water supply sentry wells; monitoring of plume nature and extent; monitoring of source areas; remedial system performance including in-plant monitoring and system performance and ecological impact monitoring; and remedial investigations.

## 5.5 USEPA and MADEP Oversight Activities

The USEPA and MADEP personnel provided regulatory review and oversight for design, construction, and operational phases of the FS-1 groundwater plume remediation project. They were updated frequently at technical meetings and reviewed/commented on investigation and design documents.

The IRP office continues to keep the regulatory agencies informed of system operations and maintenance, monitoring, and system modifications. In addition, the regulatory agencies review the SPEIM reports, which may contain information about proposed changes to the existing system or monitoring network. The proposed modifications are discussed and implemented with regulatory concurrence.

# 6.0 FINAL INSPECTION AND CERTIFICATIONS

## 6.1 Remedial Action (RA) Contract Inspections

Section 5.3 described the QA/QC followed for construction of the FS-1 ETD system. Inspections were conducted throughout the construction phase by contractors, AFCEE personnel, and Title II services. Nonconformance reports were prepared any time a condition existed that did not comply with drawings, specification codes, workmanship standards, or Air Force contract requirements. The inspectors were required to document all discrepancies that could not be corrected immediately. Final acceptance reports were filed to detail required re-testing, examinations, or changes in identification of any replacement parts used in correcting the problem.

Turnover packages are used to document the inspection and testing of equipment and facilities. Each package contains pertinent drawings, process and instrument diagrams, process flow diagrams, QA/QC checklists, punch-lists and sign-off sheets. This turnover system allows for a step-by-step inspection, testing, and turnover of each system and subsystem to ensure the smooth startup and commissioning of the entire plant.

## 6.2 Health and Safety

The prime contractor responsible for designing and constructing the FS-1 ETD system was Jacobs Engineering Group (JEG). JEG has a strict health and safety program that adheres to hazard communication programs, safety training, medical surveillance programs, and personal protective equipment.

Hazard Communication

JEG Employee Hazard Communication training (HAZCOM) includes at a minimum:

- methods and observations that can be used to detect the presence or release of a hazardous chemical in the work area (such as the kind of monitoring conducted by O&M personnel, continuous monitoring devices, and visual appearance or odor of hazardous chemicals);
- the physical and health hazards of the chemicals in the work area; and
- the measures employees can take to protect themselves from these hazards, including specific procedures implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and proper personal protective equipment.

Plant chemical hazard information is provided to all potentially affected personnel. Information concerning specific chemical hazards and the appropriate protective measures are provided by:

- developing and maintaining a written hazard communication program for the workplace, including lists of all hazardous chemicals present;
- properly labeling chemical containers;
- distributing Material Safety Data Sheets; and
- developing and implementing employee training programs on the hazards of chemicals and protective measures.

Safety Training:

All personnel involved with the construction of the FS-1 ETD were trained in accordance with federal Occupational Safety and Health Administrations (OSHA) regulations. Personnel entering controlled areas were required to have successfully completed 40 hours of hazardous waste instruction off-site, three days of actual field experience under the direct supervision of a trained experienced supervisor, and eight hours of refresher training annually.

Prior to commencement of treatment operations, all site personnel, including visitors and suppliers, who enter controlled areas were required to attend a site-specific safety and health training session. These sessions were conducted by site safety personnel to ensure that all personnel were familiar with the requirements and responsibilities of maintaining a safe and healthy work environment.

Periodic on-site safety training was conducted and addressed safety and health procedures, work practices, and changes in work task or schedule, results of previous monitoring, review of safety discrepancies and accidents, and activity hazard analyses.

Medical Surveillance

All personnel working on site were included in the medical surveillance program. Subcontractor personnel working on site were required to provide documentation that they participated in a medical surveillance program that complied with state and local regulations. Documentation of current medical surveillance exams was maintained.

The medical surveillance program included scheduling examinations, certification of fitness for duty, compliance with OSHA requirements, and information provided to the physician. The medical surveillance program maintained records of the frequency and content of the examinations.

Personal Protective Equipment (PPE)

The level of personal protective equipment (PPE) was determined by the Program Health and Safety Manager (PHSM). Appropriate levels of protection for each work activity were established by the PHSM based on a review of historical site information, current data, and an evaluation of potential for exposure (inhalation, dermal, ingestion, and injection) for each task. The PHSM also was required to establish action levels for any upgrade or downgrade in levels of PPE. The protocols and communication network for changing the level of protection addressed air monitoring results, potential for exposure, changes in site conditions, work phases, job tasks, weather, temperature extremes, and individual medical considerations.

## 6.3 Operating Properly and Successfully

Jacobs Engineering Group, AFCEE's design/construction contractor for the system, submitted a project note to AFCEE on December 10, 2003, documenting the basis for transferring the operations of the FS-1 remedial system to CH2M Hill, AFCEE's MMR operations and maintenance contractor. **Appendix B** presents Project Note No. 10, *Summary of FS-1 System Trial Operations and Transfer of Operations to O&M.* Jacobs Engineering was responsible for monitoring system operations and troubleshooting problems since the onset of generally continuous system operations on October 15, 2003. During this time Jacobs Engineering coordinated the resolution of key punch list items as part of concluding system construction activity (see **Appendix A** for FS-1 Pre-Final Inspection and Project Punch List). **Appendix C** presents the letter submitted by AFCEE to the USEPA officially documenting the successful achievement of the FS-1 treatment plant system startup milestone pursuant to the Federal Facility Agreement nine days prior to the enforceable milestone deadline of October 10, 2003.

## 7.0 OPERATION AND MAINTENANCE (O&M) ACTIVITIES

Long-term operations are referred to as O&M, and long-term monitoring is referred to as the SPEIM program in this document. O&M activities begin during the system startup and will continue throughout the life of the treatment system. SPEIM activities began prior to the startup of the FS-1 Quashnet River and Bogs pilot system with the collection of baseline data. This section discusses both the O&M and SPEIM activities associated with the FS-1 groundwater plume treatment system.

### 7.1 Post-construction O&M

The FS-1 ETD system began operating on October 1, 2003. The new FS-1 treatment system includes a total of four extraction wells, three GAC adsorption vessels, three surface water discharge bubblers, and two frac tanks. Bubblers are vertical riser pipes constructed of 18-inch corrugated metal, designed to cascade water out of the pipes in order to aerate and increase the dissolved oxygen concentration in the discharged water. The surface water bubblers discharge water to the perimeter ditches of the K1 and K2 (west ditch) bogs. These bog ditches are a tributary to the Quashnet River.

The FS-1 ETD system operated continuously, extracting, treating, and discharging approximately 750 gpm of groundwater. The treatment system uses GAC to remove EDB to concentrations below the detection limit. The reporting limit for EDB Analytical Method 504.1 is 0.01 micrograms per liter (µg/L); detection limits are lower than reporting limits. At a flow rate of 750 gpm, the residence time in the lead GAC vessel is 12 minutes. Additionally, no treatment for metals removal is needed for the FS-1 plume.

O&M activities generally include treatment plant monitoring, carbon exchanges, backwashes, well inspection and maintenance, flow rate and pressure monitoring, making appropriate adjustments, and conducting routine/periodic maintenance. These activities are managed by the O&M staff and are described in the following sections.

#### 7.1.1 O&M Personnel and Responsibilities

To ensure attainment of high availability and capacity factors for all the treatment systems at MMR, an operations staff is present ten hours per day, seven days a week. The maintenance staff is present eight hours per day, five days a week. There are six Massachusetts licensed (certified) wastewater treatment plant operators on staff. In addition to the O&M crews, there is also a Project Manager, Project Engineer, and Plant Superintendent on staff. The following information provides the duties and responsibilities of the personnel. The description of these duties and responsibilities also serves to provide the information regarding the types of O&M activities at MMR treatment plants.

O&M Manager

The O&M Manager is directly responsible for all treatment plant operations and leads the O&M group by organizing, planning, coordinating, and directing the O&M effort. Specific responsibilities include:

- implementation of plans (e.g. quality program plan, health and safety plan, O&M plan);
- management of the O&M effort in accordance with contractual requirements;
- operation of the treatment plants in accordance with all established environmental/cleanup objectives and requirements;
- maintenance of the treatment plants in a manner that exhibits high standards of stewardship for government property and ensures sustained achievement of high availabilities and capacity factors;
- supervision of the O&M staff;
- preparation of all internal and external reports and data records; and,
- communication regarding O&M issues with AFCEE.

O&M Project Engineer

The O&M Project Engineer reports directly to the O&M Manager. The engineer provides technical and management support to the Project Manager and assists the Plant Superintendent with technical matters. Duties include:

- providing technical and staff support to O&M staff;
- operations and plant startup/modifications/expansion support;
- procedure development;
- diagnosing and solving process and equipment problems;
- maintenance of project documents/manuals/record drawings;
- technical liaison between O&M group and technical support groups, (e.g., SPEIM staff, engineering staff, drilling/well maintenance staff, and analytical/chemistry staff); and,
- preparing reports and analyzing trends utilizing plant databases.

Plant Superintendent

The plant superintendent reports directly to the O&M manager and has the following responsibilities:

- supervision of the O&M staff;
- responsibility for the safe, compliant, and efficient operation of all treatment plants;
- hands-on implementation of the plans, project procedures, and plant operations-related requirements of the QPP and HSP;
- management of the plant sampling effort;
- preparation of routine operational reports and notifications;
- management of process residuals (i.e. used GAC) in compliance with all regulatory requirements; and
- management of assigned government property.

Plant Operators

The Plant Operators report directly to the Plant Superintendent and are responsible for performing routine plant operations and, when necessary, assisting with maintenance activities. Specific responsibilities include:

- control/monitor plant operations;
- perform daily plant walk downs, including visual checks and inspections of facilities and equipment;
- prepare chemical feeds and manage process residuals as required;
- maintain plant logs and prepare routine operating reports;
- collect monthly compliance samples;
- collect routine plant process samples and perform in-house analyses;
- interpret analytical results and make adjustments/corrections as appropriate;
- conduct carbon exchanges as required;
- maintain grounds and facilities;
- assist the maintenance staff as required; and
- conduct plant tours when scheduled.

Maintenance Supervisor

The Maintenance Supervisor reports directly to the Plant Superintendent and is responsible for:

- maintenance planning and execution for all treatment plants;
- supervision of the maintenance staff;
- development and implementation of planned/preventative maintenance programs utilizing a computerized maintenance management system;
- preparation of work schedules and coordination of maintenance activities with operational requirements;
- development of work methods and maintenance procedures;
- management of the spare parts and tools inventories;
- management of all maintenance contracts, contractors, and purchases;
- preparation and closeout of work orders;
- development and implementation of an instrument calibration program; and,
- the provision of hands-on troubleshooting/maintenance support of control system hardware and software.

Maintenance Technicians

The Maintenance Technicians report directly to the Maintenance Supervisor and are responsible for:

- performing all hands-on maintenance activities;
- performing both planned and emergency mechanical and electrical repairs;
- executing and closing out work orders;
- calibrating instruments;
- lubricating and adjusting equipment; and
- preparing orders for replacement parts.

All O&M personnel are trained to satisfy all applicable regulatory requirements, observe/implement all applicable site safety and quality standards and procedures, and conduct all job-related responsibilities and functions efficiently and effectively. Training includes initial and refresher training in the following categories:

- OSHA Hazardous Waste Operations and Emergency Response

(HAZWOPER);

- cardiopulmonary resuscitation (CPR)/first aid fundamentals;
- wastewater treatment plant operator certification,
- orientation for site safety, treatment plant processes, and computer controls;
- confined space entry;
- lock-out/tag-out procedures;
- chemical handling and PPE;
- sampling;
- laboratory analysis and use of test equipment;
- records/reports/administration;
- plant familiarization;
- hands-on operation; and,
- hazardous operations (HAZOP) analysis.

### 7.1.2 Plant Monitoring and Sampling

Plant monitoring and sampling are conducted at all MMR treatment plants to verify that the plants are operating within design parameters; ensure that the treatment systems achieve compliance with approved design objectives; and, assess if ecological resources are being adversely impacted. The results are reported in weekly operations reports and in documents generated under the SPEIM program.

The DQOs for in-plant sampling and monitoring are:

- to determine contaminant concentrations in influent, effluent from the lead GAC vessel, and plant effluent;
- determine when carbon replacement is required;
- verify that the system provides effluent water that meets the cleanup levels; and
- ensure the treatment system is not adversely affecting nearby ecosystems.

### 7.1.3 Chemical Additions to FS-1 Treatment Plant

There are no chemicals added to the FS-1 plume treatment process.

### 7.1.4 GAC Change-outs

The FS-1 treatment system includes a carbon adsorption system consisting of three GAC vessels. The GAC vessels each contain 20,000 pounds of carbon and operate in series. The valve arrangement allows the flexibility necessary to accomplish the various tasks of emptying and filling carbon, backwashing carbon, and changing the lead, intermediate, and lag position of the vessels. Each of the carbon vessels is 10 feet in diameter and 18 feet in height. The units are constructed of carbon steel with an epoxy interior lining.

The three GAC vessels operate in series, with one unit acting as the lead vessel, one as the intermediate vessel, and one unit acting as the lag (guard) vessel. The lead vessel removes the bulk of the contaminants, the intermediate vessel allows the lead vessel loading to be maximized, and the guard vessel polishes the treated water by removing any low levels of EDB that may remain in the treated water after it exits the intermediate vessel. Breakthrough is defined as detectable concentrations of EDB above the reporting limit in samples collected between the second and third vessels. Upon breakthrough, new GAC is ordered. When delivered, the carbon in the lead vessel is replaced. The vessel flow sequence is then changed so that the former intermediate vessel becomes the lead vessel, the former lag vessel becomes the intermediate vessel, and the newly charged vessel becomes the lag vessel.

### 7.1.5 GAC Backwashes

In order to ensure the most efficient use of the GAC vessels, they must be backwashed to remove entrained solids. Backwash water and filtered solids (sludge) are collected in backwash/sedimentation (frac) tanks. Two frac tanks (FTK #1 and FTK #2) are located immediately adjacent to the treatment building for backwash operations. Each frac tank has a working volume capacity of 16,000 gallons. FTK #1 is used to store treated water for carbon backwashing and FTK #2 is used to store spent backwash water. The solids are allowed to settle to the bottom of the tank, which is enhanced with polymer addition, and the supernatant is decanted and processed through the treatment plant. Periodically, solids that have accumulated in the bottom of the tank(s) are disposed off-site. A subcontractor transfers the sludge from the tank to a vacuum truck, and transports it to a permitted wastewater treatment plant.

### 7.1.6 Well Inspection and Maintenance

The combined treatment capacity of all MMR treatment plants is approximately 12 million gallons per day. To ensure optimal contaminant capture, minimal impact on the environment, and operational longevity, it is essential that each of the approximately 100 extraction and reinjection wells operate as designed. Well performance is consistently monitored and any deficiencies corrected. A well inspection and maintenance plan has been established to proactively monitor well performance and build an information

database that can be used to schedule and predict the need for preventative well maintenance (i.e., refurbishment).

The 2004 FS-1 SPEIM report scheduled for completion in the spring of 2005 provides specific information related to the well inspection and maintenance operations for the FS-1 treatment system. The FS-1 wellfield has four extraction well pumps numbered EWP-401, EWP-405, EWP-407, and EWP-411. Each pump features a variable frequency drive that controls the pump motor speed to match the flow set-point. The range of operational flow rates for each well pump and the motor horsepower is shown in **Table 7-1**. The total plant influent flow is 750 gpm.

**Table 7-1 Projected Variations in Pumping Rates**

| Extraction Well Pump | Normal Operating Flow (gpm) | | Design Flow Ranges (gpm) | HP |
|---|---|---|---|---|
| | Yrs 0-4 | Yrs 5-15 | | |
| EWP-401 | 150 | 150 | 150-300 | 30 |
| EWP-405 | 250 | 150 | 150-300 | 30 |
| EWP-407 | 150 | 100 | 100-200 | 20 |
| EWP-411 | 200 | 350 | 100-350 | 40 |
| Total | 750 | 750 | 500-750 | |

Outside of the voluntary changes in flow rates, there are cases in which the flow rates begin to decrease (i.e. due to bio-fouling) over time. The well and pump inspection/maintenance program will provide the data necessary to track declining performance trends. Well and pump performance thresholds have been established to schedule well and/or pump maintenance activities before impacting plume capture. These performance thresholds will be used to assure that the wells and pumps continue to operate in accordance with the wellfield performance design criteria. Threshold levels are expressed as a percentage of decline from the original performance standard. The pump performance threshold is measured as a specified decline in total dynamic head produced at a given flow rate as depicted on the manufacturer's pump curve. The well performance threshold is measured as a specified decline in specific capacity from the original level when the well was constructed. The maintenance threshold values will be specified in the FS-1 2004 SPEIM report.

The following operating procedures are considered in order to maximize capture efficiency when the treatment plant goes down or a well or a number of wells are not working properly:

- If the system is down less than three days, restart the system at design rates.
- If the system is down 3-10 days, each well in the wellfield should be run at 10% above the design flow rate for the number of days that the system was down.
- If the system is down longer than 10 days, the wells in the wellfield should be run at their maximum capacities for the number of days the system was off.

- If the plant experiences (planned or unanticipated) reduced flows, below the full system design rate, reduce the flow at each well proportional to the design flow rates.
- If an individual well is off line more than 72 hours, pump the adjacent two wells (one on either side of the inoperable well) at their maximum capacity for the number of hours that the well was off line.
- If a well is more than 20% below design flow rate for longer than 72 hours, increase the pumping in the adjacent two wells (one on either side of the inoperable well) at the pump's maximum capacity.
- During low/high (below and above design) total system flow conditions, evenly distribute the treated water to the re-injection wells.

## 7.2 Monitoring Program

SPEIM activities, as the name implies, include both system performance and ecological impact monitoring. System performance monitoring refers to the performance evaluation of the groundwater treatment systems. This is accomplished by routinely measuring groundwater levels (i.e. hydraulic analyses) and chemistry via a network of monitoring wells. The numbers, locations, and depths of the monitoring wells are selected to allow for the efficient and timely detection of any significant changes in indicator parameters. Ecological monitoring refers to collecting and analyzing hydrological, surface water, and sediment and biological data to monitor whether the treatment systems affect an ecological resource. These activities are managed by the SPEIM group. The FS-1 chemical, hydraulic, and surface water monitoring networks, and the in-process sampling port locations within the FS-1 treatment plant are presented in **Figures 3-1, 3-2, 3-3**, and **3-4** respectively.

## 7.3 Future Groundwater Restoration Activities

Future groundwater restoration activities at FS-1 include continued monitoring, optimizing the monitoring well network, optimizing the flow rates from the extraction wells (including shutting down wells as appropriate), and remapping the plume as it is remediated. This work will continue until cleanup goals are met.

## 8.0 SUMMARY OF PROJECT COSTS

This section discusses and compares the estimated costs associated with the selected remedy from the FS-1 ROD (Alternative 3B: Axial and Leading Edge Extraction, Treatment, and Reinjection/Discharge) and actual costs associated with the FS-1 groundwater treatment systems constructed in 1999 (Quashnet River and Bogs Pilot Test) and 2003 (FS-1 ETD). Estimated costs were provided in Appendix F of the FS-1 ROD (AFCEE 2000a).

The Quashnet River and Bogs Pilot Test began operating in April 1999 and consisted of one deep extraction well and 175 shallow well-points. This treatment system had an initial maximum flow rate of 650 gpm; however, after optimizations the flow rate was increased to 750 gpm. Additionally, earthen berms were constructed to separate surface water contaminated with EDB from clean groundwater upwelling into the bogs. These berms were an integral part of the pilot test system because they served as secondary containment/surface impoundment in the event that a power outage occurred and extracted contaminated groundwater drained from the treatment plant to the bogs. The treatment plant was destroyed by a fire in October 2002.

The FS-1 ROD was finalized in April 2000. The selected remedy included groundwater extraction and treatment at the leading edge of the plume, groundwater extraction and treatment along the axis of the plume, reinjection/discharge of treated water, and institutional controls to prevent usage of the aquifer during cleanup. Additionally, surface water and groundwater were to be monitored for the life of the treatment system (predicted to be seven years) and earthen berms were to be constructed to separate river water contaminated with EDB from clean groundwater upwelling in the bogs.

The selected remedy in the FS-1 ROD designated the existing Quashnet River and Bogs Pilot Test and newly constructed earthen berms as an interim remedy and intended these components to be incorporated as part of the final remedial action. Before construction of the final remedy, the ROD required that additional modeling and design be performed to optimize the extraction system. This was accomplished in the FS-1 Wellfield Design Report (AFCEE 2001).

The final remedy (FS-1 ETD groundwater treatment system) began operation in September 2003 and consists of four extraction wells with a combined flow rate of 750 gpm. Several components of the interim remedy were used by the new treatment system, including the deep extraction well, surface water bubblers, and earthen berms; however, because a fire destroyed the interim remedy's treatment plant in October 2002, the facility had to be rebuilt rather than modified. The major components of the selected remedy, the interim remedy, and the final remedy are presented in **Table 8-1**.

**Table 8-1**
**Comparison of the Components of the ROD's Selected Remedy, Quashnet River and Bogs Pilot Test, and FS-1 ETD Remedial System**

| Remedial System Components | ROD Selected Remedy | | Interim Remedy Quashnet River and Bogs Pilot Test | | Final Remedy FS-1 ETD Remedial System | |
|---|---|---|---|---|---|---|
| | Number | Units | Number | Units | Number | Units |
| Extraction Wells | 18 | 600 gpm | 1 | 200-300 gpm | 4 | 750 gpm |
| Shallow Groundwater Extraction Well-points | 135 | 400-450 gpm | 175 | 450 gpm | NA | NA |
| Granular Activated Carbon Vessels | Yes | NA | 2 | 2,000 lbs | 3 | 20,000 lbs |
| Shallow Reinjection Trench | NA | NA | 1 | 120 gpm | NA | NA |
| Surface Water Discharge Bubblers | 1 | 800 gpm | 1 | 530 gpm | 3 | NA |
| Reinjection Wells | 19 | 200 gpm | NA | NA | NA | NA |
| Total Flow Rate | NA | 1,000-1050 gpm | NA | 650-750 gpm | NA | 750 gpm |

The selected remedy presented in the ROD anticipated that the treatment systems would achieve cleanup goals within seven years. AFCEE has revised that estimate and now predicts that the FS-1 ETD groundwater treatment system will achieve its cleanup goals in FY 2029 with O&M activities ending in FY 2030 and ecological impact monitoring ending in FY 2033. Also, AFCEE plans on completing a residual risk analysis in FY 2031 and, depending on the results of the analysis, plans on decommissioning the FS-1 ETD remedial system in FY 2032.

The following subsections provide a comparison of the actual and projected project costs for the first seven years of remedial system operation (actual costs for the first six years of operation and an estimate of costs for the final year) versus the ROD estimated costs for seven years of remedial system operation (1999 through 2006), and an estimation of project costs for the remaining anticipated lifetime of the remedial action (i.e. 2007 through 2033).

## 8.1 Total ROD Estimated Cost versus Total Actual Cost for FS-1 Treatment Systems

The present worth of the total estimated cost for implementation of the ROD's selected remedy including remedial system construction, institutional controls, and seven years of operation and maintenance and SPEIM activities, was $10,561,000. The actual cost for implementation of the interim and final remedies for the first six years and the estimated

cost for the remaining year is $18,241,000. The estimated costs for O&M, SPEIM, and additional property acquisition activities for the remaining anticipated lifetime of the remedial system is $16,822,000. The total cost for the remedial action is anticipated to be approximately $35,064,000.

## 8.2 Bog Separation Project Cost Comparison

The following table presents a comparison of ROD estimated costs versus actual costs for the construction and maintenance of earthen berms designed to separate river water contaminated with EDB from clean groundwater upwelling in the bogs. The applicable year is provided with all actual costs.

**Table 8-2**
**Bog Separation Project**
**Comparison of Actual Costs versus the ROD Estimated Cost**

| FY | Description | Actual Costs | ROD Estimated Cost |
|---|---|---|---|
| | Berms | | $1,010,000 |
| 1998 | Bog Separation Project | $77,000 | |
| 2000 | Bog Maintenance at FS-1 | $178,500 | |
| 2008 | Berm Mitigation Project | $648,000 (estimated) | |
| | **Sub Total** | **$904,000** | **$1,010,000** |

The selected remedy (Alternative 3B) provided an estimated cost of $1,010,000 for all work relating to the construction of earthen berms in the Quashnet Bogs. Actual costs include the total of the costs to construct and maintain the earthen berms, and the estimated cost for future berm mitigation. The actual cost is approximately 90% of the ROD estimated cost.

## 8.3 Remedial System Construction Cost Comparison

Table 8-3 presents a comparison of ROD estimated remedial system construction costs versus actual costs. The applicable year is provided with all actual costs.

The ROD estimated value is a combination of the construction costs of the treatment facility with the construction costs of the extraction and reinjection/discharge system. The actual cost is approximately 1.3 times greater than the ROD estimated cost. Since neither the ROD nor the Feasibility Study provide a detailed breakdown of the estimated costs, it is assumed that the difference in costs is due to an underestimation of the cost to construct the Quashnet River and Bogs Pilot Test, as well as the additional costs associated with constructing a new FS-1 treatment building (which had to be rebuilt because the original treatment building was destroyed in a fire) rather than modifying the existing building.

**Table 8-3**
**Remedial System Construction**
**Comparison of Actual Costs versus the ROD Estimated Costs**

| FY | Description | Actual Costs | ROD Estimated Costs |
|---|---|---|---|
| 1999 | Construction of Interim Remedy (Quashnet River and Bogs Pilot Test) | $4,493,000 | $1,597,000 |
| 2002 | Construction of Final Remedy (FS-1 ETD) | $107,000 | $3,188,000 |
| 2003 | Construction of Final Remedy (FS-1 ETD) | $2,066,000 | |
| | **Sub Total** | **$6,666,000** | **$5,059,000** |

## 8.4 Remedial System O&M Cost Comparison

The following table presents a comparison of ROD estimated remedial system O&M costs versus actual costs. The applicable year is provided with all actual costs.

**Table 8-4**
**Comparison of Remedial System O&M Costs (Years 1-7)**
**Actual Costs versus the ROD Estimated Costs**

| FY | Description | Actual Costs | ROD Estimated Costs |
|---|---|---|---|
| | Treatment Facility O&M (Years 1-7) | | $3,691,000 |
| 2000 | IRA Operations and Maintenance | $306,174 | |
| 2001 | IRA Operations and Maintenance | $311,219 | |
| 2002 | IRA Operations and Maintenance | $351,085 | |
| 2002 | Well Abandonment | $45,000 | |
| 2003 | RA Operations and Maintenance | $229,080 | |
| 2003 | Shallow Well-point Decommissioning | $111,445 | |
| 2004 | RA Operations and Maintenance | $337,558 | |
| 2005 | RA Operations and Maintenance | $211,810 | |
| 2006 | RA Operations and Maintenance (estimated) | $205,456 | |
| 2031 | Residual Risk Analysis (estimated) | $50,000 | |
| 2032 | FS-1 System Decommissioning (estimated) | $400,000 | |
| | **Sub Total** | **$2,559,000** | **$3,691,000** |

The actual remedial system O&M costs are 70% of the ROD estimated cost for years one through seven. Since the neither the ROD nor the Feasibility Study provide a detailed breakdown of the estimated costs, it can be assumed that the differences in the selected remedy and the final remedial design (i.e. the reduction of extraction wells from 17 to four, the elimination of the 19 reinjection wells, and the change in GAC vessel design) has reduced the estimated O&M, utility, and carbon change-out costs. Additionally, since a residual risk analysis and the system's decommissioning costs were likely part of the ROD estimated cost, they were included in this comparison even though the current estimated timeframe for these activities is FY 2031 and FY 2032 respectively.

## 8.5 System Performance and Ecological Impact Monitoring Cost Comparison

The following table presents a comparison of ROD estimated SPEIM costs versus actual costs. The applicable year is provided with all actual costs.

**Table 8-5**
**System Performance and Ecological Impact Monitoring (Years 1-7)**
**Comparison of Actual Costs versus the ROD Estimated Costs**

| FY | Description | Actual Costs | ROD Estimated Costs |
|---|---|---|---|
| | Source Area Well Sampling (Years 1-7) | | $15,000 |
| | Long-term Groundwater Modeling (Years 1-7) | | $353,000 |
| | System Effectiveness Monitoring (Years 1-7) | | $81,000 |
| 2000 | SPEIM | $768,828 | |
| 2001 | SPEIM (IRA-Ops) | $450,380 | |
| 2002 | SPEIM (RA-Ops) | $792,407 | |
| 2003 | SPEIM | $385,000 | |
| 2003 | Regional Modeling/Database | $61,724 | |
| 2004 | SPEIM | $734,033 | |
| 2004 | USGS Studies | $182,917 | |
| 2004 | Data Management | $52,450 | |
| 2005 | SPEIM | $557,339 | |
| 2005 | USGS Studies | $138,800 | |
| 2006 | SPEIM (estimated) | $548,979 | |
| | **Sub Total** | **$4,673,000** | **$449,000** |

The actual cost for the FS-1 SPEIM program is approximately 10 times greater than the ROD estimated cost for years one through seven. The cost difference can be attributed to an underestimation of the SPEIM costs for the project.

## 8.6 Property Acquisition Cost Comparison

The following table presents a comparison of ROD estimated property acquisition costs versus actual costs. The applicable year is provided with all actual costs.

**Table 8-6**
**Property Acquisition (Years 1-7)**
**Comparison of Actual Costs versus the ROD Estimated Costs**

| FY | Description | Actual Costs | ROD Estimated Costs |
|---|---|---|---|
| | Property Acquisition (Years 1-7) | | $340,000 |
| 2001 | Real Estate Acquisitions | $167,151 | |
| 2002 | Real Estate Acquisitions | $55,851 | |
| 2004 | Real Estate Acquisitions | $354,680 | |
| 2005 | Real Estate Acquisitions | $274,044 | |
| 2006 | Real Estate Acquisitions (estimated) | $120,000 | |
| | **Sub Total** | **$972,000** | **$340,000** |

The actual cost for real estate acquisition is approximately three times greater than the ROD estimated cost for years one through seven. The cost difference can be attributed to an underestimation of future real estate acquisition costs in the ROD.

## 8.7 Administrative and Institutional Control Cost Comparison

The following table presents a comparison of ROD estimated administrative costs and institutional control costs versus actual costs. The applicable year is provided with all actual costs.

**Table 8-7**
**Administrative Costs and Institutional Costs (Years 1-7)**
**Comparison of Actual Costs versus the ROD Estimated Costs**

| FY | Description | Actual Costs | ROD Estimated Costs |
|---|---|---|---|
| | Administrative Costs, Institutional Controls and 5-Year Reviews | | $274,000 |
| 1998 | Plume Response Support Program | $115,716 | |
| 1998 | Cranberry EDB Uptake Study and Compensation | $1,187,500 | |
| 2000 | Connecting Potentially Impacted Mashpee Residents to Town Water | $486,000 | |
| | **Sub Total** | **$1,789,000** | **$274,000** |

The actual cost for administrative costs and institutional controls is approximately seven times greater than the ROD estimated cost. The cost difference can be attributed to an underestimation of the costs for cranberry compensation and connecting the potentially impacted residents of the Town of Mashpee with town water.

## 8.8 SPEIM and O&M Costs Associated with the FS-1 Groundwater Remedial System from 2007 through 2030

The selected remedy presented in the ROD anticipated that the treatment system would achieve its cleanup goals within seven years. AFCEE has revised that estimate based on the most recent groundwater modeling performed as part of the FS-1 SPEIM program (AFCEE, 2005). AFCEE now projects the FS-1 ETD groundwater treatment system will achieve its cleanup goals in FY 2029 with O&M activities ending in FY 2030 and groundwater monitoring continuing until FY 2033, for an additional estimated cost of $16,823,000 (in 2005 dollars).

The estimated costs for O&M and SPEIM assume a 1.5% reduction in costs per year due to reduced plume size and treatment system optimization. A breakdown of the estimated costs associated with the additional years of treatment system O&M and SPEIM activities and additional property acquisitions is presented below:

- The estimated cost for long-term operations of the treatment system including groundwater remediation, GAC change-outs, and the utility costs is $205,000 in FY 2007, and the annual cost is gradually reduced to $132,000 in FY 2030 for a total cost of $4,054,000.
- The estimated cost for SPEIM activities is approximately $541,000 in FY 2007, and the annual cost is gradually reduced to $324,000 in FY 2033 for a total of $11,662,000.
- The estimated annual cost for real estate acquisitions is $120,000 per year from 2007 through 2010 for a total of $480,000.

## 9.0 OBSERVATIONS AND LESSONS LEARNED

1. The FS-1 system incorporates three carbon vessels in series to treat EDB, as opposed to the standard two-carbon-unit treatment train. This modification is anticipated to increase the efficiency of carbon utilization and reduce long-term O&M costs over the life of the treatment plant.

2. The FS-1 system incorporates the use of variable frequency drives to adjust groundwater extraction rates at individual well sites. The use of variable frequency drives is anticipated to reduce lifecycle power consumption and enhance pump life.

3. A fire destroyed the treatment plant used in the Quashnet River and Bogs Pilot Test in October 2002. In order to reduce the chance of a fire destroying the new treatment plant, the following steps were taken: (1) the security system was upgraded; (2) the fire alarm system was upgraded; (3) the building was constructed of metal instead of wood and fenced in; (4) the electric meter was installed on a pole separate from the building rather than on the exterior wall opposite the electrical panel.

4. Recommendations made by O&M personnel on treatment plant and extraction well underground vault design were incorporated.

5. The infiltration ditch installed as part of the Quashnet River and Bogs Pilot Test was intended to aid hydraulically in plume capture, but operational and monitoring data gathered by the SPEIM program showed that it was not needed. The infiltration ditch was not incorporated in the new treatment plant design. Working with a representative of the Massachusetts Division of Fisheries and Wildlife Southeast Wildlife District, the extra flow was sent to the upstream bubbler to improve stream habitat.

## 10.0 OPERABLE UNIT CONTACT INFORMATION

Following is contact information for AFCEE, USEPA, and MADEP:

| | |
|---|---|
| Mr. Jon Davis<br>Remedial Project Manager<br>Air Force Center For Environmental Excellence<br>322 East Inner Road,<br>Otis Air National Guard Base, MA 02542-5028<br>(508) 968-4670 ext. 4952 | Mr. Paul N. Marchessault<br>Remedial Project Manager<br>Federal Facilities Superfund Section<br>U.S. Environmental Protection Agency,<br>Region I<br>1 Congress Street, Suite 1100<br>Boston, MA 02114-2023<br>(617) 918-1388 |
| Mr. John Schoolfield, P.E.<br>Project Manager<br>Air Force Center For Environmental Excellence<br>322 East Inner Road,<br>Otis Air National Guard Base, MA 02542-5028<br>(508) 968-4670 ext. 5601 | Mr. Robert Lim<br>Project Manager<br>Federal Facilities Superfund Section<br>U.S. Environmental Protection Agency,<br>Region I<br>1 Congress Street, Suite 1100<br>Boston, MA 02114-2023<br>(617) 918-1392 |
| Ms. Rose Forbes, P.E.<br>Operations and Maintenance Project Manager<br>Air Force Center For Environmental Excellence<br>322 East Inner Road,<br>Otis Air National Guard Base, MA 02542-5028<br>(508) 968-4670 ext. 5613 | Mr. Leonard J. Pinaud, Chief<br>Federal Facilities Remediation Section<br>Massachusetts Department of<br>Environmental Protection<br>Southeast Region<br>20 Riverside Drive<br>Lakeville, MA 02347<br>(508) 946-2871 |

## 11.0 REFERENCES


AFCEE, 2004c. *Fuel Spill-1 Groundwater Treatment System Operation and Maintenance Manual*, prepared by Jacobs Engineering for AFCEE/MMR Installation Restoration Program, Otis ANGB, Cape Cod MA; September 2004.

AFCEE, 2004b. *Comprehensive Long-Term Monitoring Plan* prepared by $CH_2M$ Hill for AFCEE/MMR Installation Restoration Program, Otis ANGB, Cape Cod MA; May 2004.

AFCEE, 2004a. *Final Fuel Spill-1 2003 Annual System Performance and Ecological Impact Monitoring Report*, prepared by $CH_2M$Hill for AFCEE/MMR Installation Restoration Program, Otis ANGB, Cape Cod MA; March 2004.

AFCEE, 2001. *Final Fuel Spill-1 Wellfield Design Report*, prepared by Jacobs Engineering for AFCEE/MMR Installation Restoration Program, Otis ANGB, Cape Cod MA; December 2001.

AFCEE 2000b. *Quality Program Plan.* AFC-J23-35Q85101-M3-0002. Prepared by Jacobs Engineering Group, Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA., September, 2000.

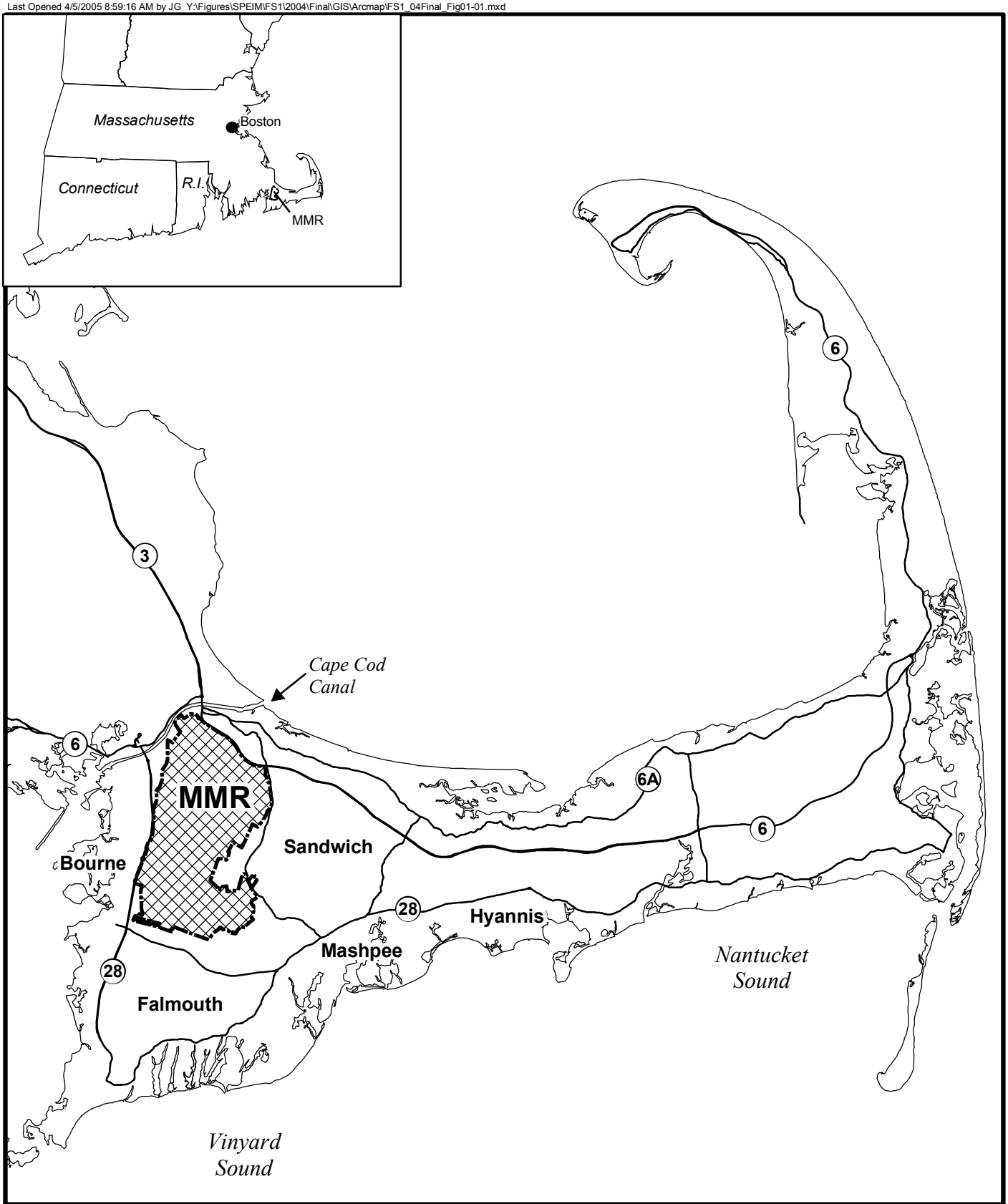
AFCEE, 2000a. *Final Record of Decision Area of Contamination FS-1*, prepared by HAZWRAP for AFCEE/MMR Installation Restoration Program, Otis ANGB, Cape Cod MA; April 2000.

AFCEE, 1999. *Final Remedial Investigation Report Area of Contamination FS-1*, prepared by HAZWRAP for AFCEE/MMR Installation Restoration Program, Otis ANGB, Cape Cod MA; May 1999.

Automated Sciences Group (ASG), 1994, *Risk Assessment Handbook*, Massachusetts Military Reservation, Cape Cod Massachusetts, Hazardous Waste Remedial Actions Program, Lockheed Martin Energy Systems, Inc., Oak Ridge, Tennessee; September, 1994.

AFCEE, 1991. *Draft Remedial Investigation Report AVGAS Fuel Valve Test Dump Site FS-1 Study Area,* Appendix I added July 1992; prepared by HAZWRAP for AFCEE/MMR Installation Restoration Program, Otis ANGB, Cape Cod MA; March 1991.

# FIGURES




Legend

Massachusetts Military Reservation

Data Source: AFCEE, December 2004, MMR-AFCEE Data Warehouse

N

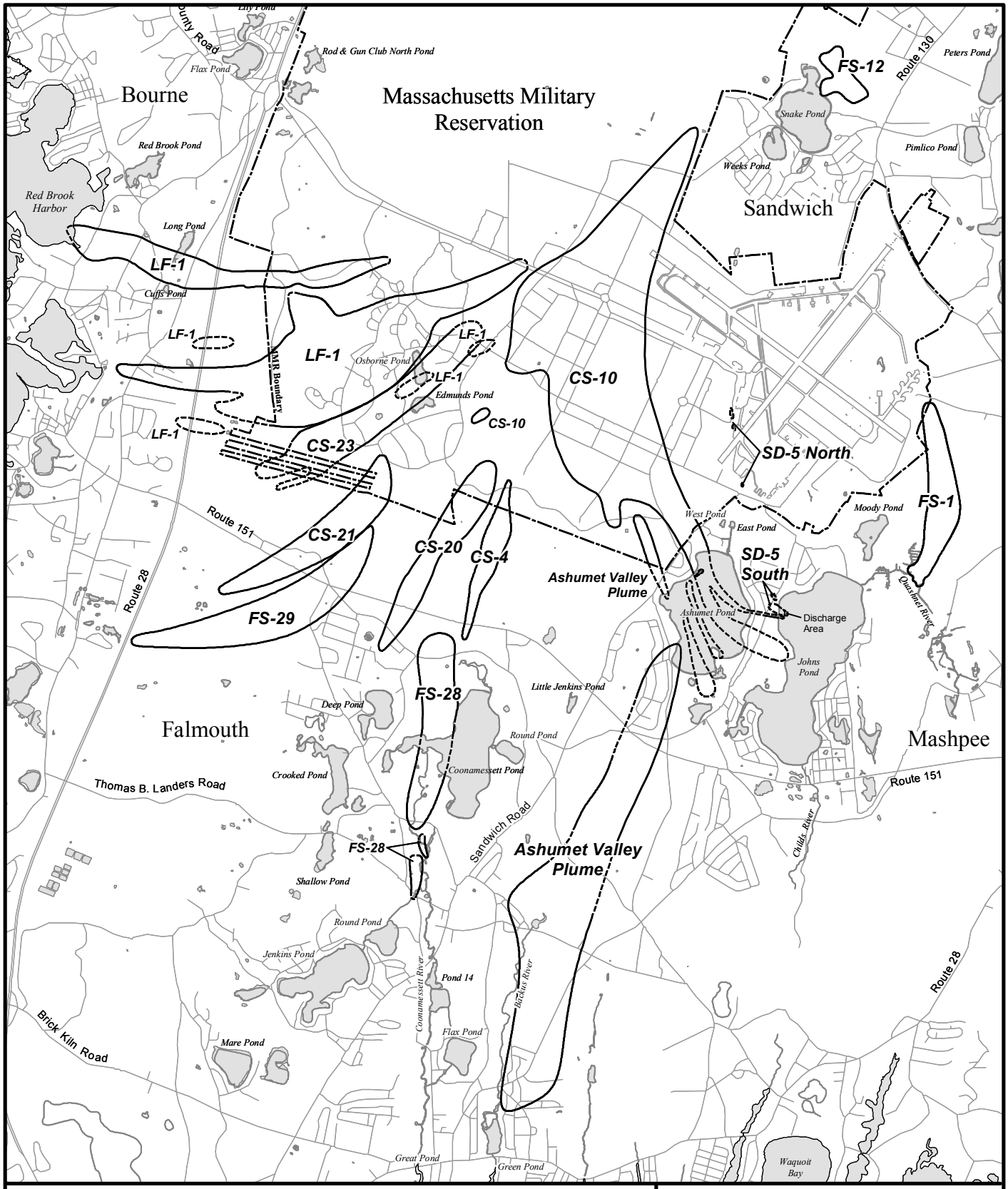
0 14,000 28,000 Feet

**FIGURE 1-1**

**MASSACHUSETTS MILITARY RESERVATION**

AFCEE - Massachusetts Military Reservation
*Final FS-1 2004 SPEIM Report*

CH2MHILL




## Legend

- Plume Boundary (Dashed Where Inferred)
- Massachusetts Military Reservation Boundary

Data Source: AFCEE, February 2005, MMR-AFCEE Data Warehouse

N

0 2,500 5,000 Feet

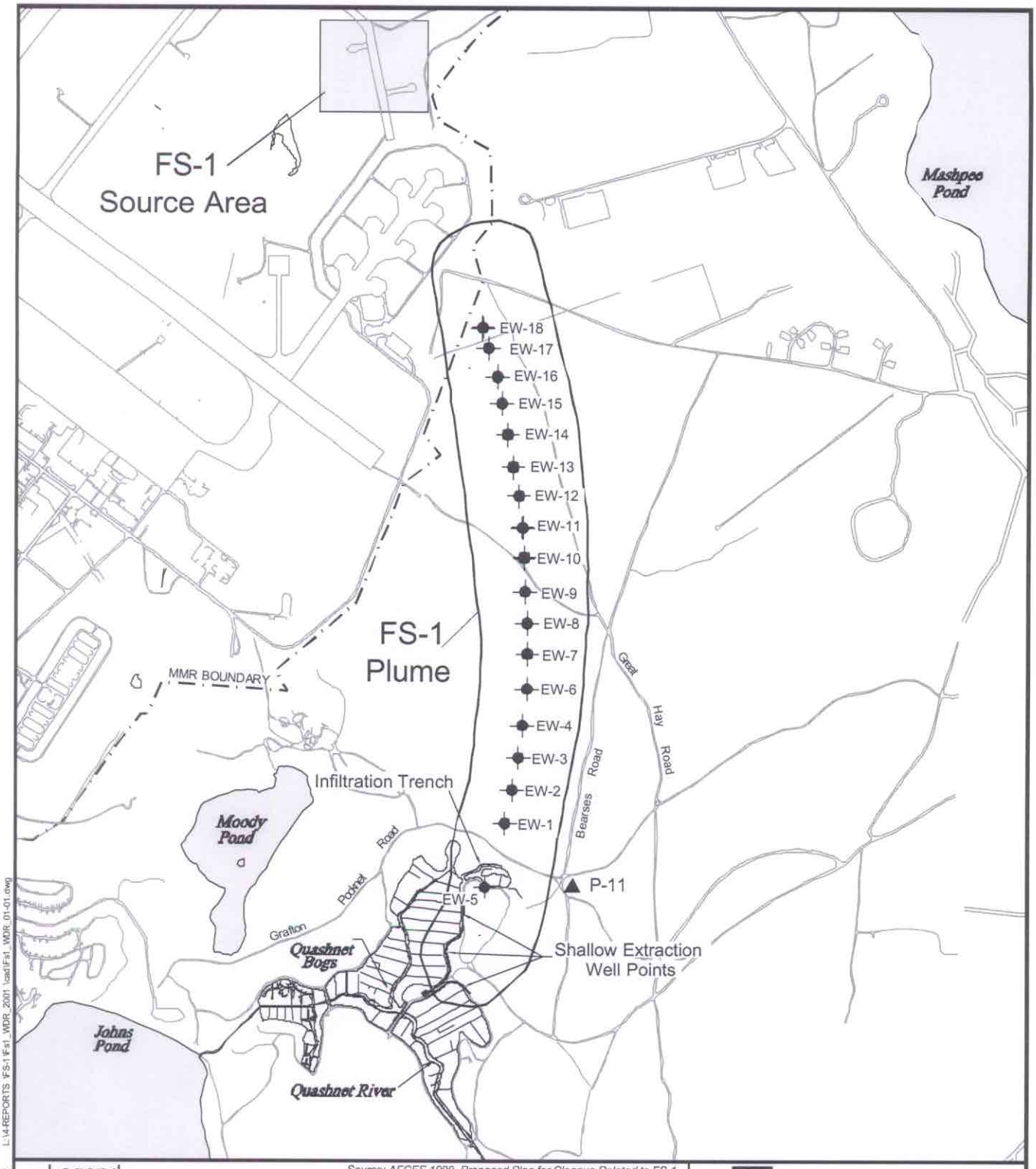
# FIGURE 1-2

## MMR PLUME MAP

AFCEE - Massachusetts Military Reservation

*Final FS-1 2004 SPEIM Report*

CH2MHILL




Legend

- Potential Public Water Supply Well Location
- Extraction Well
- Plume Contour (EDB MCL = 0.02 m g/L)
- MMR Boundary
- ROD — Record of Decision

Source: AFCEE 1999, Proposed Plan for Cleanup Related to FS-1.

0 1200

Scale in Feet

JACOBS ENGINEERING

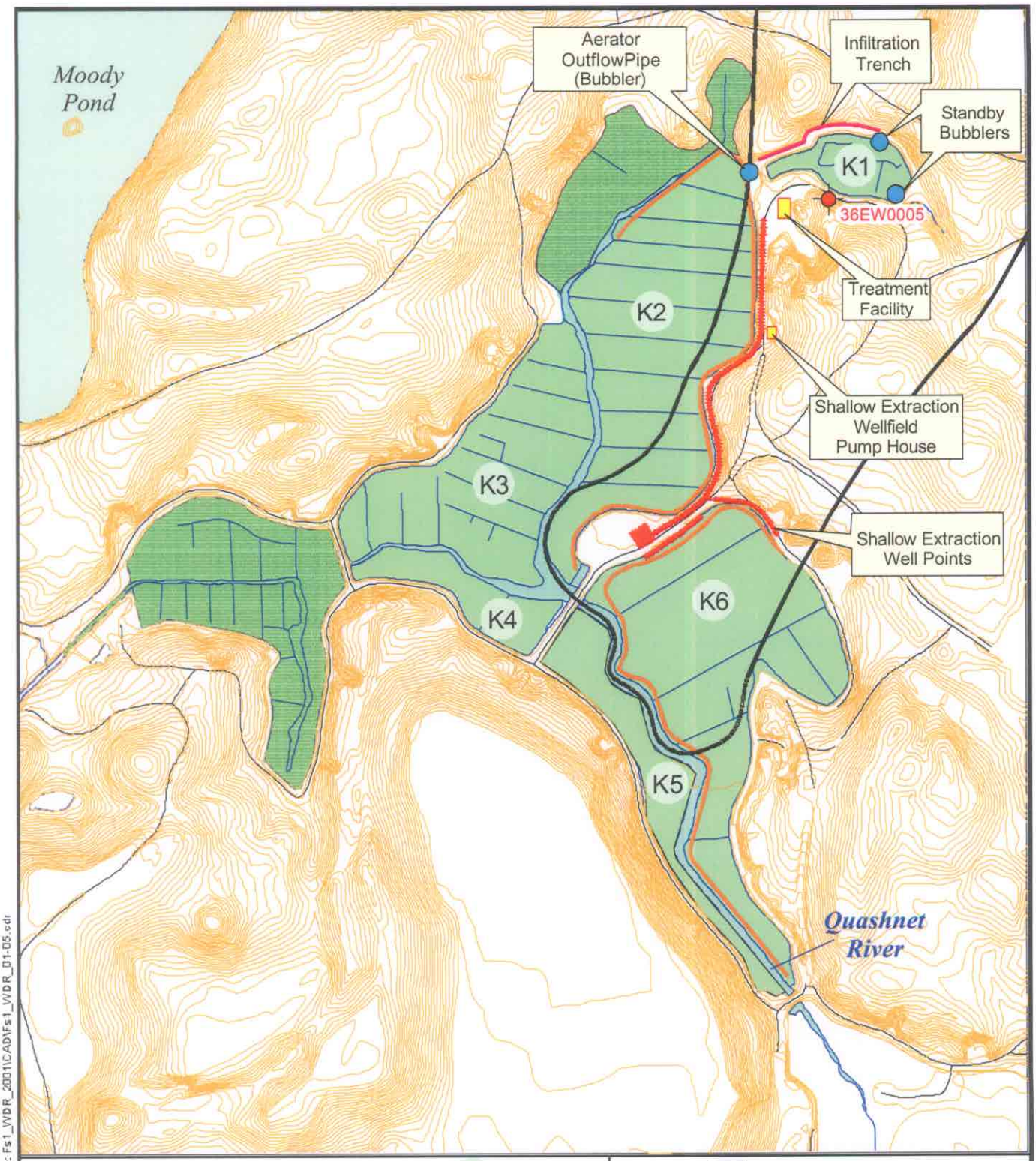
# FS-1 Plume
# Design Concept from ROD (3b)

Massachusetts Military Reservation
Cape Cod, Massachusetts

06/11/01 WR Fs1_WDR_01-01.dwg

FIGURE 2-1

last modified: 06/11/01 printed: 01/09/02 by Wr L:\4-REPORTS \FS-1 \Fs1_WDR_2001 \cad\Fs1_WDR_01-01.dwg




JACOBSENGINEERING

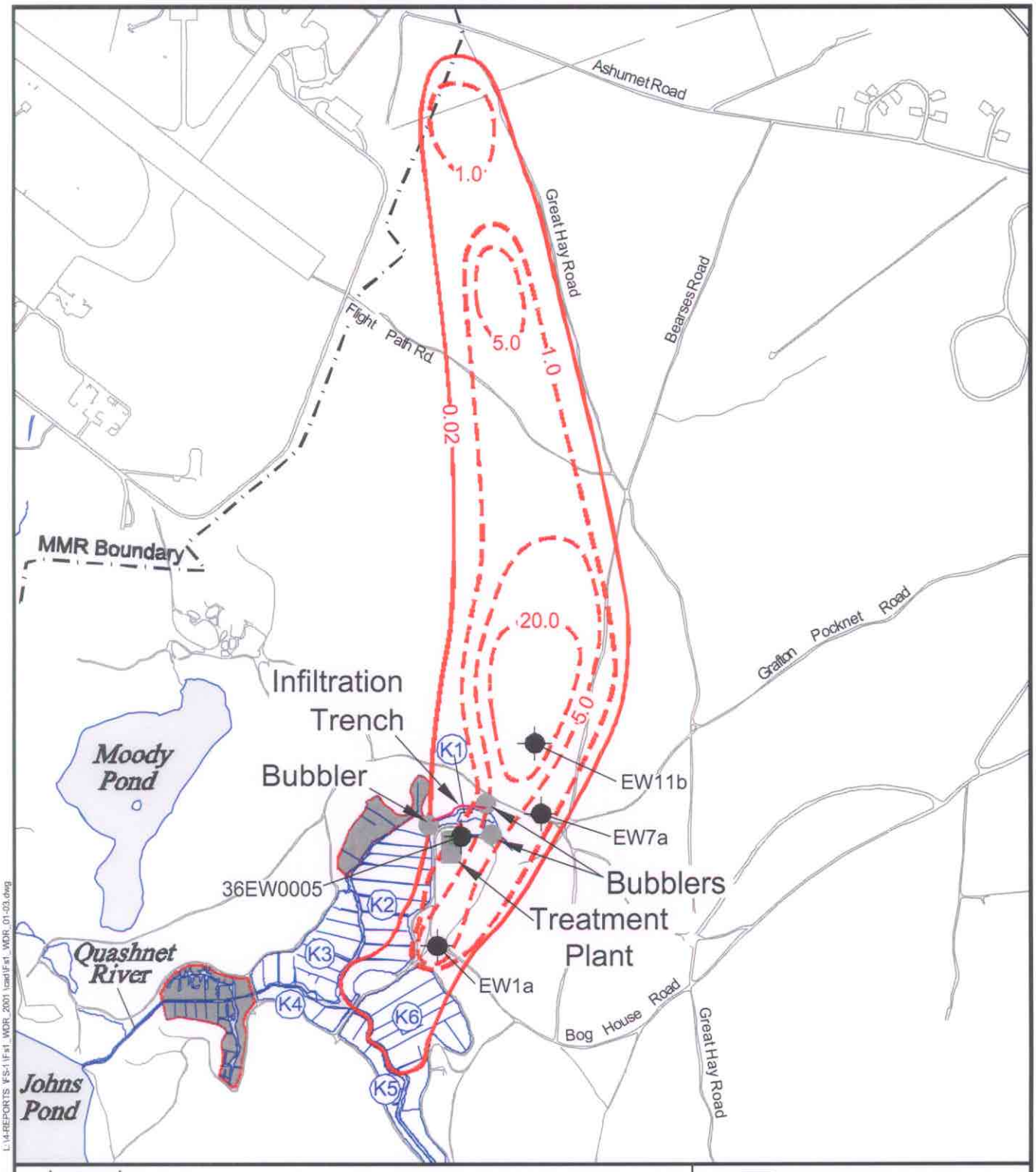
# FS-1 PILOT TEST REMEDIATION SYSTEM

Massachusetts MilitaryReservation
CapeCod,Massachusetts

6/01/01SC File:Fs1_WDR_01-05.cdr

FIGURE 2-2

L:\4 reports\fs-1\5/15/01 SC File: Fs1_WDR_2001\CADD\Fs1_WDR_01-05.cdr


Ashumet Road
Great Hay Road
Bearses Road
Flight Path Rd.
MMR Boundary
Grafton Pocknet Road
Bog House Road
Great Hay Road
1.0
5.0
1.0
0.02
20.0
5.0
Infiltration Trench
Bubbler
EW11b
EW7a
Bubblers
36EW0005
Treatment Plant
EW1a
Moody Pond
Quashnet River
Johns Pond
K1
K2
K3
K4
K5
K6
Legend
Extraction Well
Aerator (Bubbler)
Treatment Plant
MMR Boundary
EDB Plume Contour
EDB MCL=0.02 µg/L
Bog
Wetland
Note:
Contours based on October 2000 fixed well sampling results. Plume contours will have changed by the projected start-up date (October 2002)
0
900
Scale in Feet
JACOBS ENGINEERING
FS-1
Layout of Final Design
Massachusetts Military Reservation
Cape Cod, Massachusetts
06/11/01 WR Fs1_WDR_01-03.dwg
FIGURE 2-3
last modified: 06/11/01 plotted: 01/09/02 by WR L:\4-REPORTS ¥S-1\Fs1_WDR_2001 \cad\Fs1_WDR_01-03.dwg

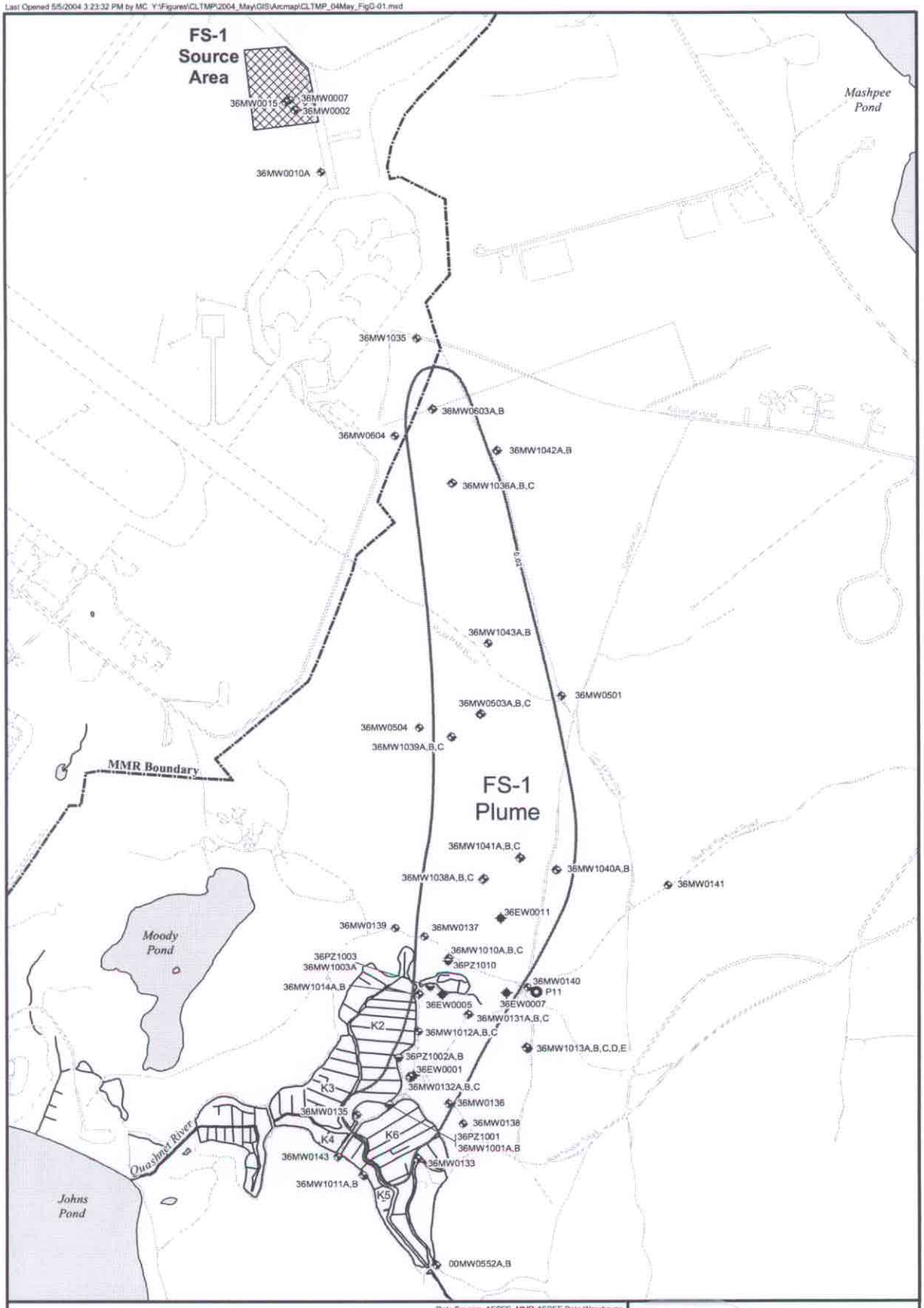



FIGURE 3-1

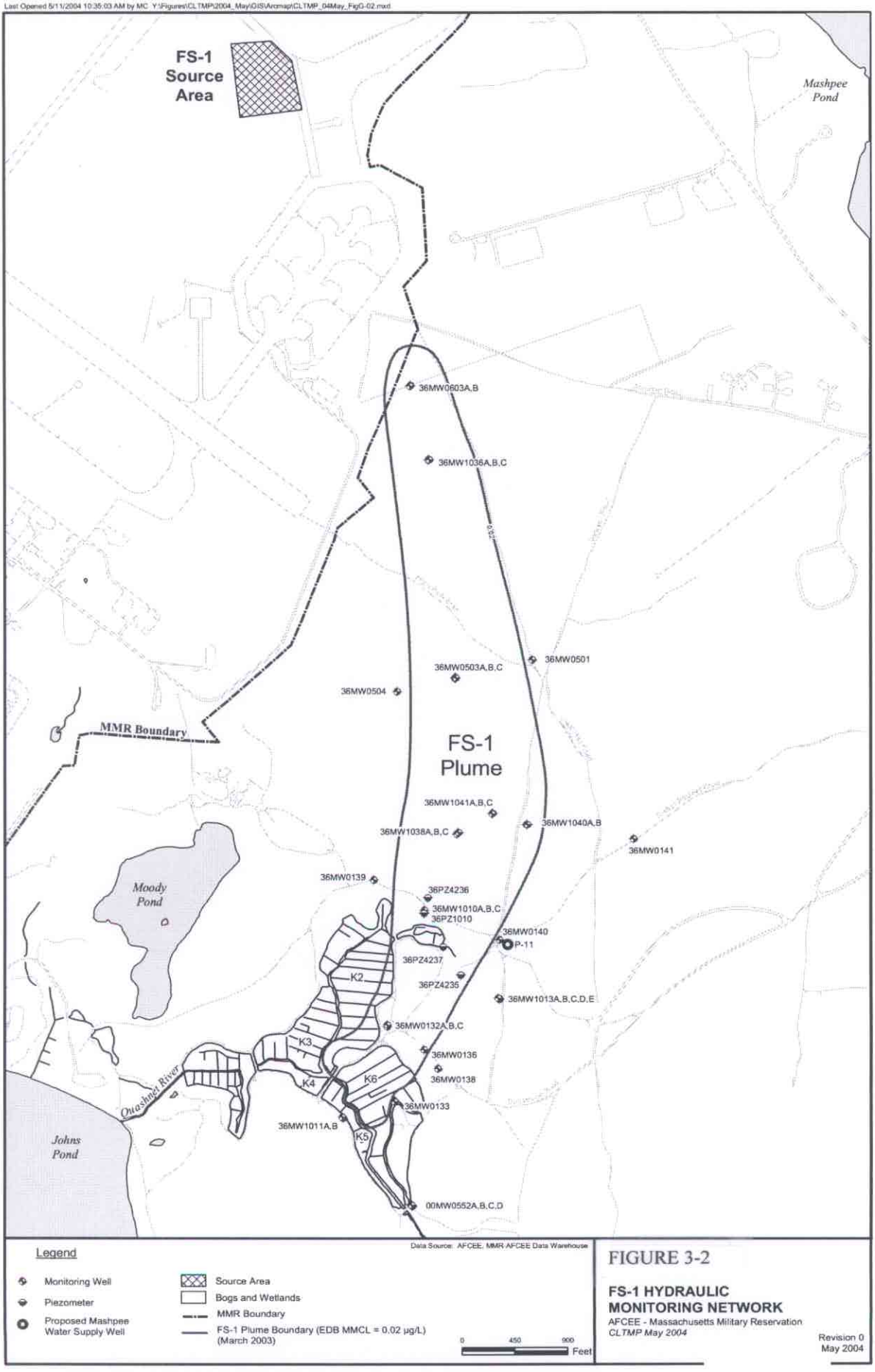
**FS-1 CHEMICAL MONITORING NETWORK**

AFCEE - Massachusetts Military Reservation

*CLTMP May 2004*

Revision 0
May 2004

CH2MHILL




# FIGURE 3-2

## FS-1 HYDRAULIC MONITORING NETWORK

AFCEE - Massachusetts Military Reservation

*CLTMP May 2004*

Revision 0
May 2004

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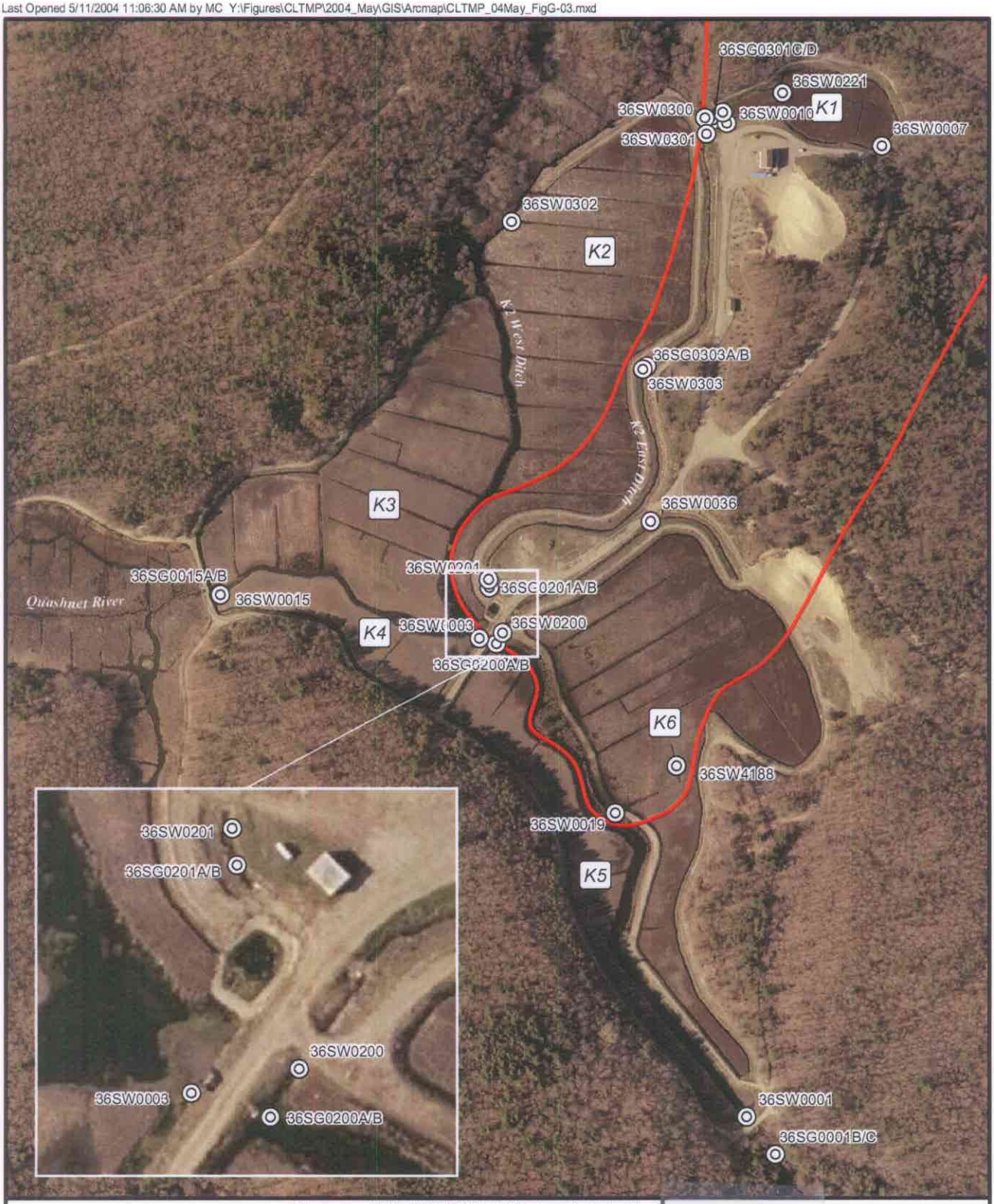



Data Source: AFCEE, MMR-AFCEE Data Warehouse September 2002
Letter designator associated with staff gauge locations is related to date of survey

Legend

FS-1 Plume Boundary
(EDB MMCL = 0.02 µg/L) (March 2003)

Surface Water or Staff Gauge Location

N

0 160 320 Feet

Spring 2002 Aerial Photography from MA ARNG

FIGURE 3-3

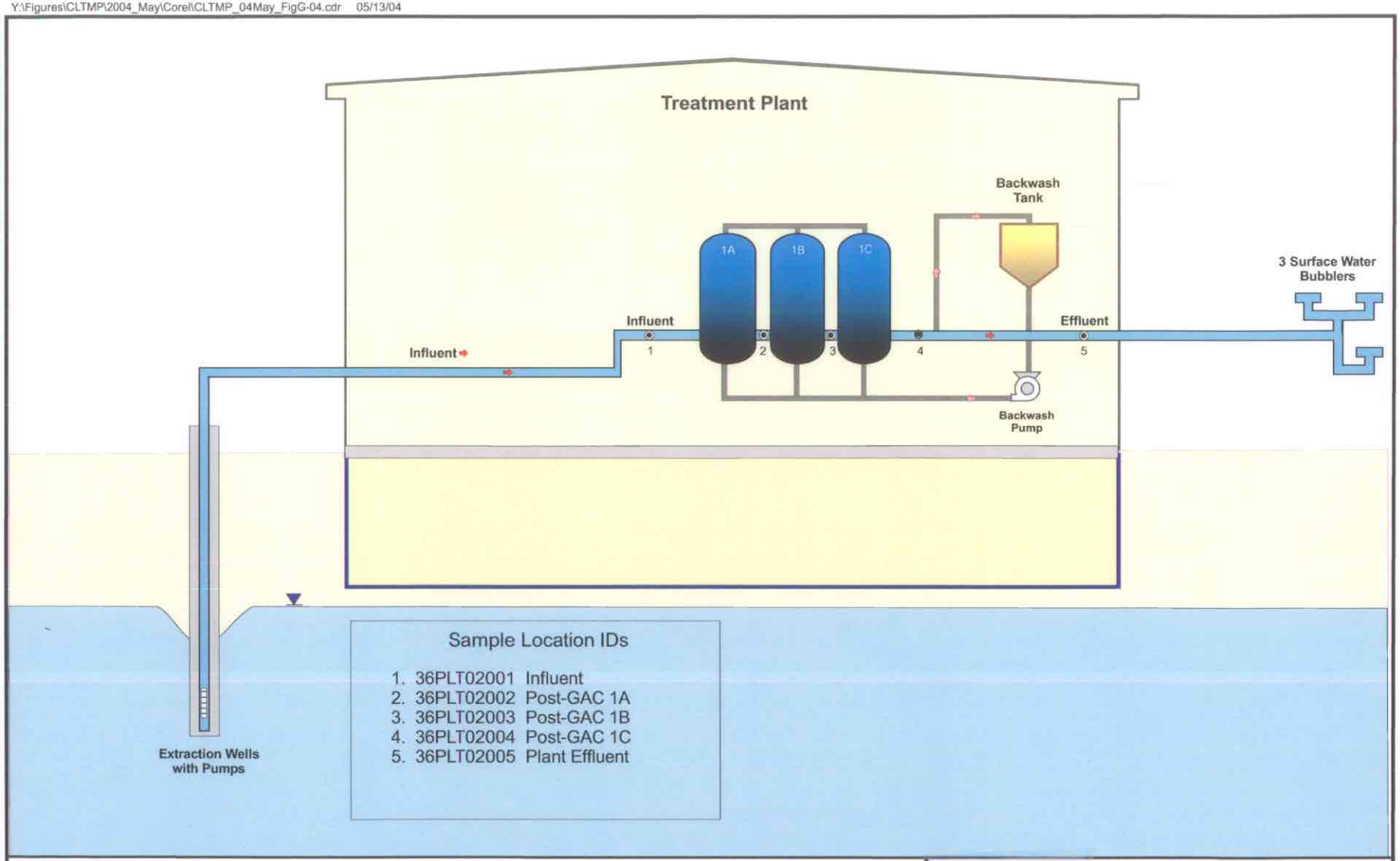
**FS-1 SPEIM SURFACE WATER MONITORING NETWORK**

AFCEE - Massachusetts Military Reservation
*CLTMP May 2004*

Revision 0
May 2004

CH2MHILL

Y:\Figures\CLTMP\2004_May\Corel\CLTMP_04May_FigG-04.cdr 05/13/04




Legend

- ◉ Sampling Port
- GAC Granular Activated Carbon
- ▼ Water Table

NOTES:

(1) Lead and lag positions are interchangeable.

FIGURE 3-4

**FS-1 TREATMENT SYSTEM**

AFCEE - Massachusetts Military Reservation

*CLTMP May 2004*

Revision 2
May 2004

CH2MHILL

# APPENDIX A

FS-1 Pre-Final Inspection and Project Punch List

CH2M HILL
318-C East Inner Road
Otis ANGB, MA 02542

CH2MHILL

November 20, 2003

Mr. Jon Davis
AFCEE/MMR
322 East Inner Road,
Otis ANG Base, MA 02542-5028

Subject: FS-1 Pre-Final Inspection for Jacobs Engineering Task Order 5, Mod 1, under Title II Inspection Contract F41624-00-D-8021, Delivery Order 0288.

Dear Mr. Davis:

As required by Contract Data Requirements List data item A050B, and referenced in Statement of Work paragraphs 4.7.1.5, CH2M HILL is submitting this report of inspection activities at FS-1 for Contract F41624-00-D-8021, Delivery Order0288.

A punch list of open items was developed by Jacobs Engineering Group as portions of the work were completed. Additional items were identified by Operations & Maintenance and by Title II Oversight personnel. These items were added to the list by Jacobs Engineering Group to produce a comprehensive punch list. On October 30, 2003, all parties met at the site and confirmed that the list included all items. CH2M HILL considers this list and site visit to be the Pre-Final Inspection (Project Punch List dated November 6, 2003 Attached). Many of the items were already closed at the time of the site meeting. The remaining items will be verified by Title II Oversight as completed as the work is performed and agreed to with Jacobs Engineering Group.

If you have any questions or comments, please contact Stephen Brand (508) 968-4670 Ext. 5604 or David Herlihy at Ext. 5605.

Sincerely,

CH2M HILL

Stephen G. Brand
cc: AFCEE/ERD(2)
LT: AFCEE/MSCD

JE REMEDIATION TECHNOLOGIES, INC.
OTIS MMR FACILITY

Thursday, November 06, 2003

# PROJECT PUNCH LIST

35Z15503

| ITEM NO. | SITE | SUB CONTRACTOR VENDOR | CONTRACT # | DATE | WORK REMAINING | LOCATION | DATE COMP | INSPECTOR | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | Clean Harbors | 35Z15503-S03-0483 | 15-Oct-03 | Clean dirt & grind filings off GAC vessels & pipe & touch-up paint as required. | | | Bud S | |
| 2 | | Clean Harbors | 35Z15503-S03-0483 | 15-Oct-03 | Additional pipe supports in AV-1 & AV-2. | | 16-Oct-03 | Bud S | |
| 3 | | Clean Harbors | 35Z15503-S03-0483 | 15-Oct-03 | Adjust pipe alignment, pipe support & expansion joints in AV-1 and AV-2. | | | Bud S | Requires plant shutdown, drain lines. |
| 4 | | Clean Harbors | 35Z15503-S03-0483 | 15-Oct-03 | Supply & install high point vent valves to frac BW suction pipe. | | 28-Oct-03 | Bud S | |
| 5 | | Clean Harbors | 35Z15503-S03-0483 | 15-Oct-03 | Supply & install PI's valves (3) to GAC vessels. | | | Bud S | This item is in process, but not within current scope. |
| 6 | | Clean Harbors | 35Z15503-S03-0483 | 15-Oct-03 | Change out bolts in sump discharge pipe fittings to valves with correct size. | | 28-Oct-03 | Bud S | |
| 7 | | Clean Harbors | 35Z15503-S03-0483 | 15-Oct-03 | Tighten bolts to fittings on sump discharge & influent flow meters. | | 28-Oct-03 | Bud S | |
| 8 | | Clean Harbors | 35Z15503-S03-0483 | 15-Oct-03 | Remove excess materials & debris. | | 28-Oct-03 | Bud S | |
| 9 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Place concrete for North & South exterior pads. | | 16-Oct-03 | Bud S | |
| 10 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Place concrete for 10' door sill. | | 16-Oct-03 | Bud S | |
| 11 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Torque GAC vessel anchor bolts. | | 28-Oct-03 | Bud S | |

| ITEM NO. | SITE | SUB CONTRACTOR VENDOR | CONTRACT # | DATE | WORK REMAINING | LOCATION | DATE COMP | INSPECTOR | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 12 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Trim, remove sharp edges & cold galvy paint anchor bolts. | | 04-Nov-03 | Bud S | |
| 13 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Crossover stairs - cold galvy paint joint repairs, install anchor bolts & grout middle supports. | | | Bud S | |
| 14 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Install 10' roll-up door. | | 28-Oct-03 | Bud S | |
| 15 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Install perimeter fence & gates. | | | Bud S | |
| 16 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Repair floor level at South end of trench. | | 16-Oct-03 | Bud S | |
| 17 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Install replacement trench grating. | | | Bud S | |
| 18 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Clean GAC vessels, pipe & paint as required. | | 04-Nov-03 | Bud S | |
| 19 | | Clean Harbors | 35Z15503-S03-0453 | 15-Oct-03 | Remove excess grout around backwash pump base. | | 28-Oct-03 | Bud S | |
| 20 | | Clean Harbors | 35Z15502-S02-0248 | 15-Oct-03 | Install four 2" blind flanges in each access vault. | | | Bud S | |
| 21 | | BETCO | 35Z15503-S02-0124 and 3 [illegible] | 15-Oct-03 | Heat Trace Pipe EW-1, 5, 7 & 11; AV-1 & AV-2; and backwash pipe to Frac Tanks. | | 29-Oct-03 | Bud S | |
| 22 | | BETCO | 35Z15503-S02-0124 | 15-Oct-03 | Install & Test Fire Detection Panel, Sensors & Pull Boxes. | | 30-Oct-03 | Bud S | Currently scheduled for 10/30/03 |
| 23 | | BETCO | 35Z15503-S02-0124 | 15-Oct-03 | Install interior & exterior lighting. | | 04-Nov-03 | Bud S | |

| ITEM NO. | SITE | SUB CONTRACTOR VENDOR | CONTRACT # | DATE | WORK REMAINING | LOCATION | DATE COMP | INSPECTOR | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 24 | | BETCO | 35Z15503-S02-0124 | 15-Oct-03 | Wire door motor. | | 29-Oct-03 | Bud S | |
| 25 | | BETCO | 35Z15503-S02-0124 | 15-Oct-03 | Seal/Caulk exterior conduits & building coduit penetrations. | | 30-Oct-03 | Bud S | |
| 26 | | BETCO | 35Z15503-S02-0124 | 15-Oct-03 | Connect grounds to fence. | | | Bud S | |
| 27 | | BETCO | 35Z15503-S02-0124 | 15-Oct-03 | Disconnect & remove outside temporary power service. | | 30-Oct-03 | Bud S | Requires plant shutdown. |
| 28 | | BETCO | 35Z15503-S02-0124 | 15-Oct-03 | Install lightning rods & cable. | | 24-Oct-03 | Bud S | |
| 29 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Install 2 roof to gutter straps. | | 04-Nov-03 | Bud S | |
| 30 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Remove temporary strips in floor control joints, clean & caulk. | | 04-Nov-03 | Bud S | |
| 31 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Mortar all exposed concrete surface holes to smooth finish. | | 04-Nov-03 | Bud S | |
| 32 | | Horton Construction | 35Z15503-S03-0366 | 15-Oct-03 | Cover & seal vinyl joints & cuts on the wall & ceiling insulation. | | 04-Nov-03 | Bud S | |
| 33 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Furnish Corning fiber QA reports | | | REM | |
| 34 | | BETCO | 35Z15503-S02-0124 | 22-Oct-03 | Furnish smoke detector removal device and 18' pole. | | | REM | Tom S. to order. |
| 35 | | Clean Harbors | 35Z15502-S02-0248 | 22-Oct-03 | Repair AV-1 vault drain leak. | | | REM | |

| ITEM NO. | SITE | SUB CONTRACTOR VENDOR | CONTRACT # | DATE | WORK REMAINING | LOCATION | DATE COMP | INSPECTOR | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 36 | | Horton Construction | 35Z15503-S03-0366 | 22-Oct-03 | Add 3" wide safety yellow paint on all interior raised pads and roll-up door curb. | | | Bud S | |
| 37 | | Clean Harbors | 35Z15502-S02-0248 | 22-Oct-03 | Fix cap on valve box for V-405 H (downstream of EW-5) so that it fits flush with ground surface. | | | Glenn | |
| 38 | | Clean Harbors | 35Z15502-S02-0248 | 22-Oct-03 | Provide water level sounding caps at three wells. | | | Glenn | Drilling |
| 39 | | BETCO | 35Z15503-S02-0124 | 22-Oct-03 | Trim sump pump power supply cable. Currently 20' long. Trim to minimum length to remove pump from sump. | | 30-Oct-03 | Glenn | |
| 40 | | BETCO | 35Z15502-S03-0508 | 22-Oct-03 | Modify VFDs to allow potentiometer control while in manual mode. | | 30-Oct-03 | Joe O | |
| 41 | | Jacobs | | 22-Oct-03 | Drill extract well electrical disconnects to make them lockable. | | 29-Oct-03 | Joe O | |
| 42 | | Clean Harbors | 35Z15502-S02-0248 | 22-Oct-03 | Repair EW-7 vault lid leaks. | | | Joe O | |
| 43 | | Clean Harbors | 35Z15503-S03-0483 | 22-Oct-03 | Correctly seat isolation valve cap on EW-5. | | 30-Oct-03 | Joe O | Duplicate of item #37 |
| 44 | | Jacobs | | 22-Oct-03 | Return items borrowed from CH2M Hill: one MOD30 controller, three pressure gauges (0-160 psig), one power strip. | | | Joe O | |
| 45 | | Clean Harbors | 35Z15502-S02-0248 | 22-Oct-03 | Confirm bolts installed in EW-1, 7 and 11 manhole covers. | | | Sterl | Drilling |
| 46 | | Bay State | 35Z15502-S03-0028 | 22-Oct-03 | Confirm locking nuts installed on pipe supports in EW-1, 7 and 11. | | | Sterl | |
| 47 | | Clean Harbors | 35Z15503-S03-0483 | 22-Oct-03 | Confirm locking nuts installed on pipe supports in EW-5. | | 28-Oct-03 | Sterl | |

| ITEM NO. | SITE | SUB CONTRACTOR VENDOR | CONTRACT # | DATE | WORK REMAINING | LOCATION | DATE COMP | INSPECTOR | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 48 | | Horton Construction | 35Z15503-S03-0366 | 22-Oct-03 | Grout GAC vessel base plates and confirm anchor bolt nuts are in-place and tight. | | 24-Oct-03 | Sterl | |
| 49 | | Jacobs | | 22-Oct-03 | Remove soil from side of frac tanks. | | 30-Oct-03 | Sterl | |
| 50 | | Clean Harbors | 35Z15503-S03-0483 | 22-Oct-03 | (for Calgon) Add pipe support bracket from GAC valve tree to end of 4" discharge pipe on PSV @ valve tree (three places). | | | Sterl | Out of Scope Item. |
| 51 | | BETCO | 35Z15503-S02-0124 | 22-Oct-03 | Ground pipe supports in plant per EGA-001. | | 28-Oct-03 | Moss | |
| 52 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Confirm unused end of light fixtures are capped and sealed @ AV-1, AV-2, EW-1, EW-7, and EW-11. | | 03-Nov-03 | Moss | |
| 53 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Confirm all gaskets, and caps and connections are installed on conduit @ AV-1, EW-1, EW-7 and EW-11. | | 03-Nov-03 | Moss | |
| 54 | | Jacobs | | 22-Oct-03 | Install 2 fire extinguishers and appropriate signs. | | | Bearc | |
| 55 | | Horton Construction | 35Z15503-S03-0368 | 22-Oct-03 | Clean debris from trench drain. | | 04-Nov-03 | Bud S | |
| 56 | | Horton Construction | 35Z15503-S03-0368 | 22-Oct-03 | Remove all excess materials and debris from site. | | 04-Nov-03 | Bud S | |
| 57 | | Horton Construction | 35Z15503-S03-0368 | 22-Oct-03 | Remove poly and tape from top of interior wall panel. | | 24-Oct-03 | Bud S | |
| 58 | | Horton Construction | 35Z15503-S03-0368 | 22-Oct-03 | Remove dirt from bldg steel. | | 04-Nov-03 | Bud S | |
| 59 | | Horton Construction | 35Z15503-S03-0368 | 22-Oct-03 | Remove dirt and concrete splatter from piping and GAC vessels. | | 04-Nov-03 | Bud S | |

| ITEM N0. | SITE | SUB CONTRACTOR VENDOR | CONTRACT # | DATE | WORK REMAINING | LOCATION | DATE COMP | INSPECTOR | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 60 | | BETCO | 35Z15503-S02-0124 | 22-Oct-03 | Make circuit breaker #14 in LP-FS1-1 GFI (unless receptacles are ground fault protected). | | 03-Nov-03 | Moss | |
| 61 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Confirm condulet covers and gaskets are installed in AV-2. | | 03-Nov-03 | Moss | |
| 62 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Install missing cover on light switch in AV-2. Secure switch to wall. | | 30-Oct-03 | Moss | |
| 63 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Install EW-401, EW-407, and EW-411 JB "panel to door" ground. | | 03-Nov-03 | Moss | |
| 64 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Install surge-protection mini power center at EW-1, EW-7 and EW-11. | | 03-Nov-03 | Moss | |
| 65 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Ground AC output filter on EW-1, EW-7, and EW-11. | | 03-Nov-03 | Moss | |
| 66 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Power heat tracing from GFCI on EW-1, EW-7 and EW-11. | | 03-Nov-03 | Moss | |
| 67 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Secure receptacle light switch at EW-7. Seal and cap unused end of receptacle box. | | 03-Nov-03 | Moss | |
| 68 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Seal and cap unused end of switch box at EW-11. | | 03-Nov-03 | Moss | |
| 69 | | Bay State | 35Z15502-S03-0028 | 22-Oct-03 | Provide correct tags on pressure gauges at EW-1, 7 and 11. | | | Carmo | |
| 70 | | Clean Harbors | 35Z15503-S03-0483 | 22-Oct-03 | Provide correct tags on EW-5 pressure guages. | | | Carmo | |
| 71 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Confirm all conduit bushings tight and box/plate seals installed on extraction well vaults. | | 03-Nov-03 | Carmo | |

| ITEM NO. | SITE | SUB CONTRACTOR VENDOR | CONTRACT # | DATE | WORK REMAINING | LOCATION | DATE COMP | INSPECTOR | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 72 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Complete lightguide label on inside door for individual fiber use, in the fiber optic panels at EW-1, 7, and 11, and at plant main control panel. | | 03-Nov-03 | Carmo | |
| 73 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Secure relays in socket using retainer strap in EW-1, 5, 7 and 11 control panels. | | | Carmo | |
| 74 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Add DIN rail end retainers to prevent component movement in EW-1, 5, 7 and 11 control panels. | | 03-Nov-03 | Carmo | |
| 75 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Add correct instrument or termination number to field-provided wires in EW-1, 5, 7 and 11 control panels and at plant main control panel. | | 03-Nov-03 | Carmo | |
| 76 | | BETCO | 35Z15502-S03-0506 and 3 5Z15503-S02-0124 | 22-Oct-03 | Ground control panel door to panel body at mfr.-provided studs at EW-1, 5, 7 & 11 & at plant main control panel. Remove paint to bare metal as required. | | 03-Nov-03 | Carmo | |
| 77 | | BETCO | 35Z15502-S03-0506 | 22-Oct-03 | Label all 110-volt AC and 24-volt DC control wiring in VFDs and VFD bypasses. | | 03-Nov-03 | Carmo | |
| 78 | | BETCO | 35Z15502-S03-0506 and 3 5Z15503-S02-0124 | 22-Oct-03 | Seal all conduits at penetrations into the plant main control panel and at the cable tray. | | 03-Nov-03 | Carmo | |
| 79 | | BETCO | 35Z15503-S02-0124 | 22-Oct-03 | Connect current indicator on backwash pump P-101 motor panel door face. | | | Carmo | |
| 80 | | BETCO | 35Z15503-S02-0124 | 22-Oct-03 | Add faceplate on plant main control panel, at top left 110-volt outlet. | | 04-Nov-03 | Carmo | |
| 81 | | Clean Harbors | 35Z15503-S03-0483 | 22-Oct-03 | Support tubing on differential pressure indicators. | | | Carmo | |
| 82 | | Clean Harbors | 35Z15503-S03-0483 | 27-Oct-03 | Remove 8" flushing strainer from the infiltration pipeline . . . during system shutdown for the AV-1 mechanical work. | | | Bud S | |
| 83 | | Horton Construction | 35Z15503-S03-0366 | 27-Oct-03 | Adjust/refit/replace overhead door trim. | | 04-Nov-03 | Bud S | |

| ITEM NO. | SITE | SUB CONTRACTOR VENDOR | CONTRACT # | DATE | WORK REMAINING | LOCATION | DATE COMP | INSPECTOR | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 84 | | Horton Construction | 35Z15503-S03-0366 | 27-Oct-03 | Add 4" wide closure piece in space between top-outside of overhead door and building frame. | | | Bud S | |
| 85 | | Horton Construction | 35Z15503-S03-0366 | 30-Oct-03 | Extend OH door sill on both ends | | 04-Nov-03 | Bud S | |
| 86 | | Clean Harbors | 35Z15503-S03-0483 | 30-Oct-03 | Vault hatch on EW-11 does not close properly | | | Joe O | |
| 87 | | Clean Harbors | 35-Z15503-S03-0483 | 30-Oct-03 | Install Pipe insulation to frac tanks and EW-5 vault piping | | | Bud S | |
| 88 | | Jacobs | | 30-Oct-03 | Clarify knox box requirements. Relay information to O&M | | | Joe O | |
| 89 | | Jacobs | | 30-Oct-03 | Confirm restoration requirements have been met | | | Joe O | |
| 90 | | Jacobs | | 30-Oct-03 | Remove soil drum from site | | | Joe O | |
| 91 | | Clean Harbors | 35-Z15502-S02-0248 | 30-Oct-03 | Provide data sheets/manuals for all furnished equipment | | | Carl | |
| 92 | | Clean Harbors | 35-Z15503-S03-0483 | 30-Oct-03 | Provide data sheets/manuals for all furnished equipment | | | Carl | |
| 93 | | BETCO | 35Z15502-S03-0506 and 3 5Z15503-S02-0124 | | Provide data sheets/manuals for all furnished equipment | | | Carl | |
| 94 | | Horton Construction | 35Z15503-S03-0366 | 30-Oct-03 | Provide data sheets/manuals for all furnished equipment | | 03-Nov-03 | Carl | |
| 95 | | Jacobs | | 30-Oct-03 | Provide plugs for vault hatch latch openings | | | Joe O | |

| ITEM NO. | SITE | SUB CONTRACTOR VENDOR | CONTRACT # | DATE | WORK REMAINING | LOCATION | DATE COMP | INSPECTOR | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| 96 | | Horton Construction | | 30-Oct-03 | Caulk around building column base plates | | 04-Nov-03 | Bud S | |
| 97 | | Jacobs | | 30-Oct-03 | Paint man doors at treatment building | | | Joe O | |
| 98 | | Jacobs | | 30-Oct-03 | Provide building numbers as required per Otis Fire Dept. | | | Joe O | |
| 99 | | Jacobs | | 30-Oct-03 | Straighten/plumb bubbler 3 | | | Joe O | Not in current scope |

# APPENDIX B

Project Note 10: *Summary of FS-1 System Trial Operations and Transfer of Operations to O&M*

JACOBS

**Document Control Number:**
ENR-J23-35Z15503 P1-0010

| Client, Project and Location | Project Note | Task Order / AFCEE Project No. / Jacobs Project No. |
|---|---|---|
| **AFCEE, MMR Plume Response Program<br>TO-0005 Mod. 1<br>FS-1 Remedial Action<br>Otis ANG Base, Massachusetts<br>F41624-01-D-8547** | **Note No.: 010** | Task Order **05**<br>AFCEE Project No. **20021500**<br>Jacobs Project No. **35-Z155-03** |

| Confirmation of | | Date Held | NA |
|---|---|---|---|
| ☒ | Project Note-P1 | Location | NA |
| ☐ | Client Meeting-P4 | Date Issued | December 10, 2003 |
| ☐ | Other | Recorded By | R. McCampbell; J. Carman |

Subject

**SUMMARY OF FS-1 SYSTEM TRIAL OPERATIONS AND TRANSFER OF OPERATIONS TO O&M**

**Fuel Spill – 1 (FS-1) Wellfield and Treatment Plant Replacement Projects**

Issued By: Jeff Carman

Jacobs Project Manager

Participants (* Denotes Part Time Participation)
N/A

| Item | Remarks |
|---|---|
| I. | **INTRODUCTION**<br><br>This project note is intended to document the basis for transfer of FS-1 remedial system operations from Jacobs, AFCEE's design/construct contractor for the system, to CH2M Hill, the AFCEE MMR operations and maintenance contractor. Jacobs has been responsible for monitoring system operations and troubleshooting problems since the onset of generally continuous system operations on 15 October 2003. During this time Jacobs has coordinated the resolution of key punchlist items as part of concluding system construction activity. Additionally, the O&M contractor has provided valuable operational assistance during the period of trial operations.<br><br>Both the AFCEE SOW and Jacobs proposal for TO 5 Mod 01 stipulate that Jacobs will start-up and commission the system to ensure optimum system performance for at least one month before transition to the O&M team. The information presented in this project note is intended to demonstrate that the system is operating as designed and that relevant ancillary activities are suitably concluded or that a mutually acceptable plan for resolution is in-place. Discussion focuses on the following categories:<br><br>• Trial operations – key operational parameters and observations and troubleshooting efforts are discussed. |

Distribution: Jacobs - Otis: Document Control, J. Carman, M. Goydas, R. McCampbell, J. Mahoney; Jacobs – OR: B. Etter
AFCEE: M. Alli, J. Schoolfield, R. Forbes; CH2M Hill: D. Herlihy



File: C:\Documents and Settings\jalves\My Documents\A F C E E\I R A R\FS-1\Appendix\Project Note 10 FS-1 TP operations.doc

| Client, Project and Location | | Task Order |
|---|---|---|
| **AFCEE, MMR Plume Response Program**<br>**FS-1 Remedial Action**<br><br>**Otis ANG Base, Massachusetts**<br>**F41624-01-D-8547** | **Project Note**<br><br>**Note No.:** 010 | **05**<br>AFCEE Project No.<br>**20021500**<br>Jacobs Project No.<br>**35-Z155-03** |

| Item | Remarks |
|---|---|
| | • Punchlist status – outstanding items are discussed.<br>• Vendor manual and O&M manual – status is discussed.<br>• Software – status is discussed.<br>• Record drawings – status is discussed.<br>• Transfer of operations to O&M – a date of 12 December 2003 (0900) is identified for transfer of operations. |
| **II.** | **SUMMARY OF TRIAL SYSTEM OPERATIONS**<br><br>Generally continuous remedial system operations for the repaired and reconstructed FS-1 plant and wellfield were initiated on 15 October 2003. Prior to the onset of continuous operations, system proof-of-process and engineering start-up activities were conducted to establish the fundamental operational condition of the system and design compliance.<br><br>Proof-of-process consisted of treatment of an initial 30,000 gallons of contaminated groundwater from Extraction Well No. 1 (36EW0001). The treated water was held in frac tanks and discharged via the bubbler system upon receipt of analytical data confirming EDB removal in accordance with the treatment process.<br><br>Following the proof-of-process effort, engineering start-up was conducted. This entailed establishing reliable communications between the extraction wells and the treatment plant and between the treatment plant and the Sandwich Road Treatment Facility (SRTF), development of engineering redlines and punchlist items, testing of key system components over defined operating ranges, and testing of critical system interlocks. **Attachment 1** (FS-1 Start-up Report) provides additional information on this effort.<br><br>Upon initiation of continuous unattended operations, a range of operational parameters were monitored and a schedule for collection of process water samples was established. Details of this trial operating period are described below and in attachments (**Attachment 2** FS-1 Wellfield Operating Data and **Attachment 3** FS-1 Plant Operating Data).<br><br>A. <u>Volume of Water Treated</u><br><br>The trial operation period was October 15 to December 8, 2003, or a total of 54 days. The theoretical maximum volume of groundwater treated, operating at the design flow of 750 gallons per minute (gpm) the entire 54 days is 58,320,000 gallons. The actual total volume of groundwater treated for the trial period is calculated to be 47,340,000 gallons, based on well pump run-times, which are recorded in the variable frequency drives (VFDs) and individual well flows. The percentage of actual volume treated compared to the theoretical maximum is 82%. The plant totalized flow for the period, based on the Bubbler #3 & #4 flow |

| Client, Project and Location | | Task Order 05 |
|---|---|---|
| **AFCEE, MMR Plume Response Program**<br>**FS-1 Remedial Action** | **Project Note** | AFCEE Project No. **20021500**<br>Jacobs Project No. **35-Z155-03** |
| **Otis ANG Base, Massachusetts**<br>**F41624-01-D-8547** | **Note No.:** 010 | |

| Item | Remarks |
|---|---|

meter/totalizer (FE-110 Badger meter) is 48,872,000 gallons (refer to **Attachment 3** table), which is similar to the calculated volume of treated water.

B. System Run-Time

The total well run-time is automatically recorded for each well at the VFD of each well. The total run-time for each well, accumulated since start-up of the wellfield, are as follows:

EW-1: 1,171 hours (equivalent to 49 days)
EW-5: 917 hours (equivalent to 38 days)
EW-7: 1,002 hours (equivalent to 42 days)
EW-11: 1,159 hours (equivalent to 48 days)
4,249 hours

The theoretical maximum run-time during the trial period is 5,184 extraction well hours (54 days * 24 hours/day * 4 wells) and the total actual run-time for the plant was 4,249 extraction well hours, or 82% of the available run time.

C. System Down-Time

During the trial period the plant flow was kept at the design flow of 750 gallons per minute (gpm), except during the following periods of reduced flows:

- 10-27-03 to 11-10-03 when plant flow was 500 gpm due to trouble shooting of controls at EW-5.
- 11-15-03 to 11-17-03 when plant flow was 600 gpm due to a pipe-fitting leak at AV-1.
- 11-19-03 to 11-20-03 when plant influent flow was 0 gpm and all wells were shutdown due to punchlist repairs in Access Vault-1, Access Vault-2.
- 12-2-03, plant influent flow was 0 gpm for several hours (all wells shutdown due to power outage)
- 12-7-03 to 12-8-03 when plant influent flow was 0 gpm for 25 hours. The system was down due to a storm related power outage.

D. Wellfield Flow Contributions

For the first 31 days of the trial period (October 15 to November 14, 2003) the FS-1 Wellfield was operated at the following flow rates:

| Client, Project and Location | | Task Order 05 |
|---|---|---|
| **AFCEE, MMR Plume Response Program**<br>**FS-1 Remedial Action** | **Project Note** | AFCEE Project No. **20021500**<br>Jacobs Project No. **35-Z155-03** |
| **Otis ANG Base, Massachusetts**<br>**F41624-01-D-8547** | **Note No.:** 010 | |

| Item | Remarks |
|---|---|

36EW0001 300 gpm
36EW0005 250 gpm
36EW0007 100 gpm
36EW0011 100 gpm
Total 750 gpm

On November 14, 2003 the flow rates were changed as follows to reflect design flow rates agreed to in a project note AFC-J23-35S19902-P1-0036 (21 May 2002) which addresses FS-1 system start-up phasing and shallow extraction well point operation:

36EW0001 150 gpm
36EW0005 250 gpm
36EW0007 150 gpm
36EW0011 200 gpm
Total 750 gpm

E. Plant Flow Configuration

The plant flow configuration throughout the proof of process, start-up period and trial operating period has been as follows:

Lead carbon vessel: Carbon Filter 101 (CF-101)
Intermediate carbon vessel: CF-102
Lag carbon vessel: CF-103

Plant effluent flow of 750 gpm has been split such that 54% (405 gpm) flows to Bubblers #3 and #4 and the remaining 46% (345 gpm) flows to Bubbler #2.

F. Wellfield Pump Data

The pump performance parameters of pump speed (rpm), variable frequency drive (VFD) frequency (Hz) and motor current (amps), were recorded during the trial period. These parameters were observed to increase slightly during the period (refer to **Attachments 2 and 3**). For example, 36EW0005, has been operated at 250 gpm during the trial period, while 36EW0005 parameters have increased as follows:

Pump speed has increased from 2,441rpm to 2,622 rpm
VFD frequency has increased from 42 Hz to 45 Hz
Motor current has increased from 27amps to 28 amps

| Client, Project and Location | | Task Order 05 |
|---|---|---|
| **AFCEE, MMR Plume Response Program**<br>**FS-1 Remedial Action** | **Project Note** | AFCEE Project No. **20021500**<br>Jacobs Project No. **35-Z155-03** |
| **Otis ANG Base, Massachusetts**<br>**F41624-01-D-8547** | **Note No.:** 010 | |

| Item | Remarks |
|---|---|

G. Process Pressures

Plant influent pressure has increased seven pounds/square inch gauge (psig) during the trial period from 28 psig to 35 psig. This is as expected and is likely due to carbon settling in each GAC vessel.

The GAC vessel differential pressures have risen as follows during the trial period:

Lead carbon vessel CF-101: has increased from 6.5 psi to 7.4psi = 0.9 psi
Intermediate carbon vessel CF-102: has increased from 5.1 psi to 6.8 psi = 1.7 psi
Lag carbon vessel: CF-103 has increased from 4.7 psi to 6.5 psi = 1.8 psi

Normally one expects the lead vessel differential pressure to increase the most, reflecting the normal loading of suspended solids from the wellfield, which will likely occur within 6 to 12 months. The observed differential pressure increases at CF-102 and 103 may be due to differences in the degree of carbon fines backwashing from each vessel.

H. Monitoring Results

Water samples and quality assurance field duplicates were collected for the first 30 days of the trial period and analyzed for dibromoethane (ethylene dibromide: EDB) as shown on the following table:

| Sample collection dates | Sample Desig. | 10-16-03 | 10-23-03 | 10-30-03 | 11-7-03 |
|---|---|---|---|---|---|
| EW-1 (µg/L) | 36EW0001 | 0.47 | 0.49 | 0.44 | 0.42 |
| EW-5 (µg/L) | 36EW0005 | 1.76 | 1.54 | Well off | Well off |
| EW-7 (µg/L) | 36EW0007 | 0.84 | 1.12 | 0.97 | 1.20 |
| EW-11 (µg/L) | 36EW0011 | 3.96 | 3.97 | 3.60 | 4.00 |
| Plant combined influent (µg/L) | 36PLT02001-COMBINF | 1.36 | 1.41 | 1.20 | 1.30 |
| Plant combined influent field duplicate (µg/L) | 36PLT02001-COMBINFFD | - | 1.43 | - | - |
| Post-CF101 (µg/L) | 36PLT02002-POST101 | ND | ND | ND | ND |
| Post-CF101 field duplicate (µg/L) | 36PLT02002-POST101-FD | - | - | ND | - |
| Post-CF102 (µg/L) | 36PLT02003-POST102 | ND | ND | ND | ND |
| Plant effluent (µg/L) | 36PLT02005-COMBEFF | ND | ND | ND | ND |
| Plant effluent field duplicate (µg/L) | 36PLT02005-COMBEFF-FD | ND | - | - | ND |

| Client, Project and Location | | Task Order |
|---|---|---|
| **AFCEE, MMR Plume Response Program**<br>**FS-1 Remedial Action**<br><br>**Otis ANG Base, Massachusetts**<br>**F41624-01-D-8547** | **Project Note**<br><br>**Note No.:** 010 | **05**<br>AFCEE Project No.<br>**20021500**<br>Jacobs Project No.<br>**35-Z155-03** |

| Item | Remarks |
|---|---|
| | These data demonstrate that the FS-1 treatment process has operated and continues to operate as designed.<br><br>I. <u>System Status</u><br><br>At the date of operational transfer from Jacobs to AFCEE, the FS-1 Wellfield and Plant are in good working order.<br><br>Frac Tank FTK-101 (west FTK) is 75% full and FTK-102 is 66% full. Both FTKs contain groundwater flushed from FS-1 pipelines and will require normal carbon treatment through the plant.<br><br>Analytical results are still pending (21-day turn-around) for soil samples collected 11-17-03, following an unpermitted release of water from Access Vault 1 (AV-1). Results are expected by 12-12-03. It is estimated that approximately 0.00001 lbs of EDB was released to the environment as a result of this discharge. The reportable quantity of EDB is 1 lb. as specified in the Massachusetts Contingency Plan and the AFCEE MMR notification protocol.<br><br>J. <u>Status of Erosion Controls</u><br><br>During construction Jacobs placed silt fences and hay bales at designated locations to control erosion and sedimentation effects associated with construction. Within the last month Jacobs has met with the Mashpee Conservation Commission representative, Bob Sherman to obtain feedback on the general condition of the site and the disposition of silt fencing and hay bales. Mr. Sherman prefers that the silt fence and hay bales remain in place. Removal of these items will need to be done at a later date. It is likely that this will occur after 31 January 2004, which is the close of the period of performance for this Task Order. |
| **III.** | **PUNCHLIST STATUS**<br>The status of the FS-1 Punchlist is as follows:<br><br>• 102 items identified<br>• 87 items corrected and closed,<br>• 15 items remain open, to be completed<br><br>The corrected and closed items include all identified safety related items. |

| Client, Project and Location | | Task Order 05 |
|---|---|---|
| **AFCEE, MMR Plume Response Program**<br>**FS-1 Remedial Action**<br><br>**Otis ANG Base, Massachusetts**<br>**F41624-01-D-8547** | **Project Note**<br><br>**Note No.:** 010 | AFCEE Project No.<br>**20021500**<br><br>Jacobs Project No.<br>**35-Z155-03** |

| Item | Remarks |
|---|---|
| | Jacobs and CH2M Hill Title II staff concur on the current list of closed items. It is anticipated that the remaining open items will be corrected, inspected and closed by January 16, 2004. |
| **IV.** | **VENDOR MANUAL AND O&M MANUAL**<br>Draft copies of the FS-1 Vendor Manual and Operation & Maintenance (O&M) Manual were provided to AFCEE on 09 December 2003 for review. Jacobs will incorporate AFCEE comments and issue final manuals within two weeks of receipt of comments |
| **V.** | **SOFTWARE**<br>The FS-1 software provider, Integrated Controls, Inc. (ICI) will provide software and plant operations training on 20 and 21 January 2004. In the meantime ICI has agreed to provide technical support or answer specific inquiries via telephone as necessary. |
| **VI.** | **RECORD DRAWINGS**<br>Design changes that occurred during construction were redlined by either the Jacobs start-up team or by Jacobs subcontractors. These redlines have been captured on the following 22 project record drawings:<br><br>35Z15503-3-36-E-K-N-003 Rev. 1 (11"x 17" motor schematic)<br>35Z15503 CVA001 Rev. 2 (underground pipe)<br>35Z00202 CVA001 Rev. 2 (underground pipe)<br>35Z00202 CVA002 Rev. 2 (underground pipe)<br>35Z15503-3-36-E-P-A-001 Rev. 2 (power plan)<br>35Z15503-3-36-E-Q-A-001 Rev. 1 (EW-5 Vault Details)<br>35Z15503-3-36-E-R-N-001 Rev. 1<br>35Z15503-3-36-E-S-N-001 Rev. 1 (single line)<br>35Z15503-3-36-E-L-A-001 Rev. 1<br>35Z02202-3-36-E-Q-A-001 Rev. 3 (EW-1 Vault Details)<br>35Z02202-3-36-E-Q-A-002 Rev. 3 (EW-7 Vault Details)<br>35Z02202-3-36-E-Q-A-003 Rev. 3 (EW-11 Vault Details)<br>35Z02202-3-36-E-Q-A-004 Rev. 2 (Access Vault 1 Details)<br>35Z02202-3-36-E-Q-A-005 Rev. 1 (Access Vault 2 Details)<br>35Z02202-3-36-E-Z-A-001 Rev. 3 (underground electrical)<br>35Z02202-3-36-E-Z-A-002 Rev. 3 (underground electrical)<br>35Z15503-3-36-P-G-A-001 Rev. E (GA)<br>35Z15503-3-36-P-G-A-002 Rev. E (GA)<br>35Z15503-3-36-P-G-A-003 Rev. E (GA) |

| Client, Project and Location | | Task Order |
|---|---|---|
| **AFCEE, MMR Plume Response Program**<br>**FS-1 Remedial Action**<br><br>**Otis ANG Base, Massachusetts**<br>**F41624-01-D-8547** | **Project Note**<br><br>**Note No.:** 010 | **05**<br>AFCEE Project No.<br>**20021500**<br>Jacobs Project No.<br>**35-Z155-03** |

| Item | Remarks |
|---|---|
| | 35Z15503-3-36-P-I-N-001 Rev. E (P&ID)<br>35Z15503-3-36-P-I-N-002 Rev. F (P&ID)<br>35Z15503-3-36-P-I-N-003 Rev. E (P&ID)<br><br>These drawings have been provided to AFCEE and CH2M Hill for review. Comments are due on 10 December 2003. Jacobs will incorporate AFCEE comments and issue final record drawings within two weeks of receipt of comments. |
| **VII.** | **TRANSFER OF FS-1 OPERATIONS TO AFCEE**<br><br>Based on system performance demonstrated in this document, and barring written objection, daily operational responsibility for the FS-1 remediation system will be assumed by the CH2M Hill MMR O&M team at 0900 on 12 December 2003. |

Attachments:

1. FS-1 Start-up Report
2. FS-1 Wellfield Operating Data
3. FS-1 Plant Operating Data

# APPENDIX C

Federal Facility Agreement Appendix III, Time Table 3

**DEPARTMENT OF THE AIR FORCE**
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
INSTALLATION RESTORATION PROGRAM
OTIS AIR NATIONAL GUARD BASE, MA 02542-5028

HQ AFCEE/MMR
322 E. Inner Road, Box 41
Otis ANG Base, MA 02542

3 October 2003

Mr. Paul Marchessault
U.S. Environmental Protection Agency
1 Congress Street
Suite 1100 (HOI)
Boston, MA 02114-2023

Re: FEDERAL FACILITY AGREEMENT APPENDIX III, TIMETABLE 3

Dear Mr. Marchessault

The Air Force Center for Environmental Excellence (AFCEE) herein provides notification of the start up of the Fuel Spill 1 (FS-1) groundwater treatment system. This milestone is specified in the subject timetable pursuant to the provisions of the Federal Facility Agreement between the Air Force Center for Environmental Excellence, National Guard Bureau (NGB) and the U. S. Environmental Protection Agency (EPA).

I have enclosed a copy of a letter received by AFCEE from Jacobs Engineering, which provided this office the formal notification that the start up of the groundwater treatment system at FS-1 was 1 October 2003.

If you have any questions, please contact me at (508) 968-4670, extension 4912.

Sincerely

JONATHAN S. DAVIS
Remediation Program Manager

Atch: letter

cc: MA DEP (Mr. Pinaud)
AFCEE/ERD (MAJ McClain)
Jacobs
Portage
AFCEE/MMR (Mr. Minior)

JACOBS

318 East Inner Road
Otis ANG Base, Massachusetts 02542 U.S.A.
1.508.564.5746 Fax 1.508.564.6425

03 October 2003

Mr. Jonathan S. Davis
Remediation Program Manager
HQ AFCEE/MMR
322 East Inner Road
Otis ANG Base, MA 02542-5028

SUBJECT: Contract F41624-01-D-8547
MMR Plume Response Program
TO 0005 DCN # ENR-J23-35Z15502 –G2-0001
**FS-1 Treatment Plant System Startup Milestone**

Dear Mr. Davis:

The enforceable FFA milestone for the startup of the FS-1 Treatment Plant System has been met early. On Wednesday, 01 October 2003, treated groundwater was discharged via the expanded bubbler system to the K1 and K2 bogs. This followed the extraction of approximately 34,000 gallons of water from EW-1 on 30 September. This milestone was completed 9 days prior to the FFA deadline of 10 October 2003.

Please feel free to contact me or Jeff Carman at (508) 564-5746 extension 239, if you have any questions or comments.

Sincerely,

Michael J. Goydas

Michael J. Goydas
Program Manager

MJG/mm

c: Wells Hunt, Portage (1)
Melvin Alli, HQ/AFCEE (1)
Chris Olguin, HQ/AFCEE (1)
Admin Record, AFCEE (1)
Rose Forbes, AFCEE (1)
John Schoolfield, AFCEE (1)
Mark Slechta, CH2M (1)
Jeff Carman, Jacobs (1)
Darin Williams, Jacobs (1)
Contract File, Jacobs (1)
Doc. Control File, Jacobs (1)